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DEPARTMENT OF THE INTERIOR

UNITED STATES BUREAU OF MINES
JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

MINING METHODS USED IN THE GRUNDY COAL FIELD OF BUCHANAN COUNTY, VA.

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BY

ALBERT L. TOENGES AND ROBERT L. ANDERSON

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INFORMATION CIRCULAR

DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

MINING METHODS USED IN THE GRUNDY COAL FIELD OF BUCHANAN COUNTY, VA.[1]

By Albert L. Toenges[2] and Robert L. Anderson[3]

The Grundy coal field is in process of development, and this circular was written to describe the mining methods and practices in use in the mines now being worked in this field. In lieu of man-hour labor data for individual mines a consolidated sheet of mine costs, which includes expenses for labor, material, and power, is given for all mines. The costs are for a working day only, based on average daily production. Because the demand for coal is seasonal, the costs for idle days, which vary at each mine, have not been estimated.

Approximate reserves of coal seams have been estimated from data and maps taken from Bulletin XVIII of the Virginia Geological Survey[4].

ACKNOWLEDGMENTS

Through the courtesy and cooperation of the executives and officials of the mines described and of the Norfolk & Western Railway Co. it has been possible to give general descriptions and details of mining practice. The approval of the executive of each mine was obtained for publishing the portion of the circular that refers to his operations, and the accuracy was checked.

GENERAL DESCRIPTION OF DISTRICT

Geography and Topography

The area covered by this report is adjacent to the Levisa Fork River and its tributaries - Bull Creek, Home Creek, and Lester Fork, a tributary of Knox Creek and Tug Fork. All of these streams are tributary to the Big Sandy River. Grundy, the county seat of Buchanan County, Va., is approximately in the center of this new coal field. At present, however, the

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2/ Supervising engineer, Coal Mining Section, Mining Division, U.S. Bureau of Mines.

3/ Associate mining engineer, Coal Mining Section, Mining Division, U.S. Bureau of Mines.

4/ Hinds, Henry, The Geology and Coal Resources of Buchanan County, Virginia: Virginia Geological Survey Bull. XVIII, 1918, 250 pp.

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nine operating mines are situated down the Levisa Fork from Grundy. The mine nearest to Grundy is about 7 miles northwest on Bull Creek, and those most distant are, respectively, about 20 miles northeast and adjacent to Lester Creek and approximately 20 miles down Levisa Fork near the Kentucky line.

The topography of the area is very rugged; the valleys are narrow and the slopes steep. The ridges between valleys are sharp and in most places rise about 1,000 feet above the valley. The sides of the hills are covered with underbrush and second-growth timber. In a few instances there are tracts of virgin timber, some of which are now being cut for use in mining. The gradient of the streams is steep, and although the rainfall here is considerably greater than in most parts of the United States the run-off is so rapid that there is little danger of floods.

At present access to all the mines is by unimproved dirt roads, which in rainy weather are almost impassable. Grading and widening of these roads are now in progress, and eventually good highways will result.

The Norfolk & Western Railroad serves this field over its Buchanan branch, which was built into the Grundy field during the last 7 years. The Buchanan branch extends from Devon, W. Va., a station on the main line, in a southerly direction along Knox Creek to Raitt, thence west to the Levisa Fork, passing under the divide between Knox and Levisa through a tunnel, and thence up Levisa Fork to Grundy, a total distance, including the branch lines that serve mines, of 43 miles. Construction of additional lines up Levisa Fork and Dismal Creek is in progress, and these additional lines will total 42 miles. Figures 1, 2, and 3 show the location of the railroad and of operating and proposed mines5/, together with coal areas6/.

HISTORY

Coal has been known to exist in Buchanan County for years, but until recently, because of its topography, it had no standard-gage railroad facilities. The first rail shipments of coal were made in 1932. Following is a statement of tonnage produced up to March 31, 1936:

Year	Production
1932	21,672
1933	278,853
1934	573,262
1935	7/1,365,000
First quarter of 1936	7/ 502,000

5/ From maps furnished by Norfolk & Western Railway Co.
6/ Hinds, Henry, work cited, pp. 65, 67, 73, and 75.
7/ Subject to revision.

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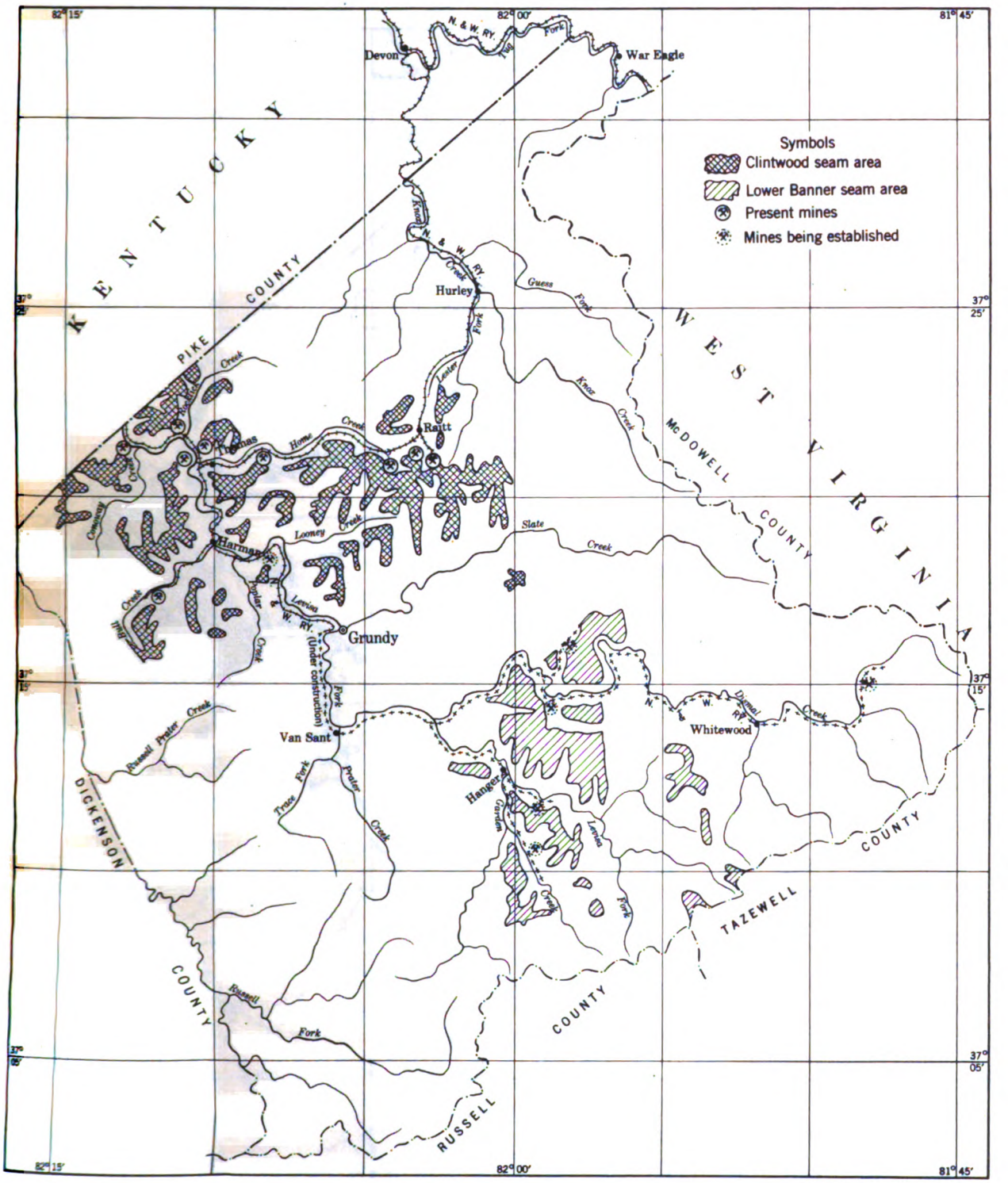

Figure 1.—Map of Buchanan County, Va., showing location of railroad, mines, and areas in which Lower Banner and Clintwood seams contain 48 inches or more of coal.

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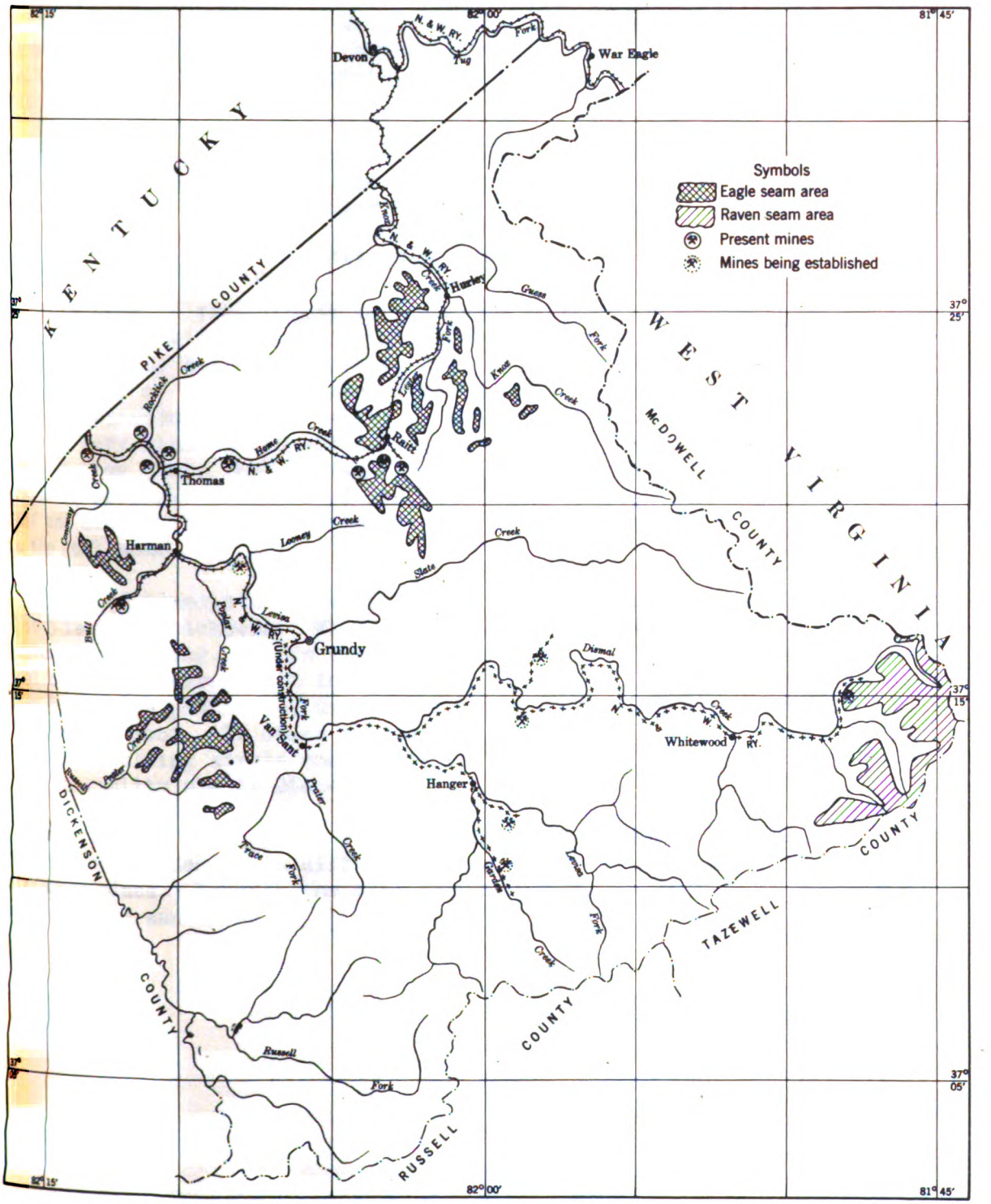

Figure 3.—Map of Buchanan County, Va., showing location of railroad, mines, and areas in which Eagle and Raven seams contain 48 inches or more of coal.

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GEOLOGY

The geology of Buchanan County has been described in detail in Bulletin XVIII of the Virginia Geological Survey[8], entitled "The Geology and Coal Resources of Buchanan County, Virginia," and will not be discussed in this circular.

Mining operations are conducted in the coal seams correlated as the Clintwood and Splash Dam. These seams vary in thickness and characteristics not only in different mines but in the same mine.

Clintwood Seam

This seam of coal ranges in thickness from 42 to 72 inches in the mines of the Grundy field. At nearly all mines there are at least two partings, one of bony coal and one of shale, each of a thickness of 1 to 5 inches. The character of these partings varies greatly; in some places one of them is not detrimental to the quality of the coal and is not discarded, but the other is very high in ash and is thrown aside. In some mines there are thin seams of gray shale that average 1/8 inch in thickness, and contain very fine grains of pyrite. One seam of this shale occurs between the coal and the roof and usually falls with the coal. It also appears at irregular intervals in the coal seam.

The roof immediately over the coal is a draw slate, which ranges from 0 to 5 feet in thickness. Where it is thick the draw slate is timbered to prevent its falling. Above the draw slate at some of the mines there is a coal seam that averages 10 inches in thickness and is called the "rider seam." In some places the draw slate falls to the rider seam, which forms a good roof. In other places this rider seam falls or comes loose from the overlying strata and has to be taken down. This rider seam is of inferior quality and is discarded.

Above the 10-inch rider seam is a hard, sandy shale. The character of the roof often changes in different areas in the same mine, as well as in different mines. Beneath the coal the bottom ranges from sandy shale and rashy coal to sandstone.

8/ Work cited.

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The proximate analysis of the Clintwood seam at one of the mines is as follows:9/

	-1 1/2-inch Nut and Slack	1 1/2-inch Nut and Slack	2 1/2x6-inch Egg	+6-inch Lump
Moisture, as received	2.0	2.8	1.7	1.9
Volatile matter, moisture free..	31.3	32.2	31.5	32.8
Fixed carbon, " " ..	61.1	60.8	61.4	62.3
Ash, " " ..	7.6	7.0	7.1	4.9
B.t.u. " " ..	14,290	14,380	14,350	14,750
Sulphur, " " ..	1.1	1.3	.9	.8
Softening temperature of ash, °F.	2,810	2,570	2,920	2,870

Splash Dam Seam

This seam of coal occurs approximately 550 feet below the Clintwood. Where it is mined it ranges from 38 to 81 inches in thickness, including partings. These partings are bone, which averages 3 inches in thickness, and shale, 1/2 to 34 inches thick.

The formation above the coal is a blue sandy shale, which makes an excellent roof. There is no draw slate.

The analysis of a composite run-of-mine sample furnished by one of the operators is as follows:

Moisture, as received	1.83
Volatile matter, moisture free	29.85
Fixed carbon, " "	65.41
Ash, " "	4.74
B.t.u., " "	14,841
Sulphur, " "	.64
Softening temperature of ash, °F. ...	2,623

9/ Tipple samples, U.S. Bureau of Mines.

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DESCRIPTION OF MINES

Mine No. 1

The thickness of the coal seam and the composition and number of partings vary at different places in the mine, but an average section is as follows:

	Inches
Coal	10
Bone, coal, and slate	2
Coal	15
Bony and rash	1 1/2
Coal	25 1/2
Total height of section	54

The roof over the coal ranges from draw slate 0 to 5 feet thick to a sandstone. A 10-inch rider seam is above the draw slate. Where the draw slate is thin it usually falls to this rider seam, and if the slate is excessively thick timbers are used to support it. The bottom consists of hard sandy shale and rashy coal.

The coal seam outcrops on the side of the hills approximately 400 feet above the tipple. The outcrop follows the contour of the hills, and in places the width of the coal area is narrow. Although there are some local variations the general dip of the seam, which is comparatively level, is to the northwest.

Mining Methods

The room-and-pillar system of mining is used.

Main entries are driven to follow ridge lines so as to divide the area between the outcrops as nearly as possible. These main entries are of the four-entry type, two being intake and two return airways in the ventilating system. The centerline between these entries is 60 feet. Branch entries are turned off these main entries toward the outcrop. These branch entries consist of an entry (haulageway) and air course driven on centerlines of 80 feet. The widths of these headings range from 18 to 20 feet and crosscuts average 80-foot centers. The pillars between branch entries are usually 300 feet.

Rooms are turned off the haulageway of the branch entries on 80-foot centers, and they are usually driven 20 feet wide and 250 feet long with break-throughs between rooms every 80 feet. The break-throughs are driven on an angle of approximately 30° from the face. A barrier pillar of 200 feet is left between the first room and the main haulageway.

Branch entries are usually turned at an angle of 75° from the main entries and rooms approximately 75° from the branch entries (parallel to the main entries). The outline of the outcrop determines the system to be used. Rooms are usually turned as the entries advance. Workings sometimes cut to the outside but as a rule stop at 20 to 80 feet from the

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outcrop. Figure 4 is a sketch of the system of development used in this mine.

At present pillars are recovered on the retreat. The line of pillar robbing is kept at approximately 45° with the entry. The open-end and closed-end methods of pillar drawing are used in this mine. If roof conditions are good pillars are drawn open-ended; if not, the closed or "pocket" system is used. Figure 4 shows both methods and the system of timbering used.

Timbering

All entries are timbered with sets consisting of two posts and a cap. In some places, where the rider seam and thick draw slate fall, it is necessary to crib with props above the entry set. Rooms are timbered with props, usually two props to a cut, one on each side of the track. Other props may be set at the face. Approximately 0.23 prop is used per ton of coal mined.

Cutting

The coal in the rooms and entries is cut with track-type cutting machines equipped with 8-foot cutter bars. The cut is made approximately 24 inches below the top of the seam and between the two partings of "bony". In some places a track-type cutting machine with a 9-foot cutter bar is used to make a horizontal cut 24 inches below the top of the seam and a vertical cut in the center of the face. The cutting machines are operated by two men - a runner and a helper. Pillar coal is undercut with a shortwall mining machine equipped with a 6 1/2-foot cutter bar. This machine is also operated by two men. The position of the cut in these places is approximately 4 inches above the bottom to prevent the cutter bar from cutting into the hard sandy shale or sandstone bottom. The 4 inches of bottom coal is recovered by the loader. The depth of the cut is usually 6 to 12 inches less than the length of the cutter bar. About 25 tons of coal are produced per cut from entries, 30 tons per cut from rooms, and 16 to 18 tons per cut from pillars when they are drawn by the closed-end method. Twenty-eight places are usually cut by each track machine in a shift and 14 places by the shortwall machine. Payment for cutting is made on a tonnage basis.

Loading

Loading is done by hand. The loader sets safety timbers, drills the face, charges the holes, fires the shots, and loads out the coal. As a rule there are two men in one working place, and cars are delivered to the loader at the face.

Three holes are drilled in the bottom of the lower section of coal, one near each rib and one in the center where the face has been cut horizontally between two partings. In places where the coal has been cut both horizontally and vertically 6 holes are drilled - two in the upper section, one near each rib and the roof, and four in the lower section near the bottom of the seam, two near each rib and two approximately 4 feet on each side from the vertical cut. The drilling is done by hand with a breast auger. Permissible explosi

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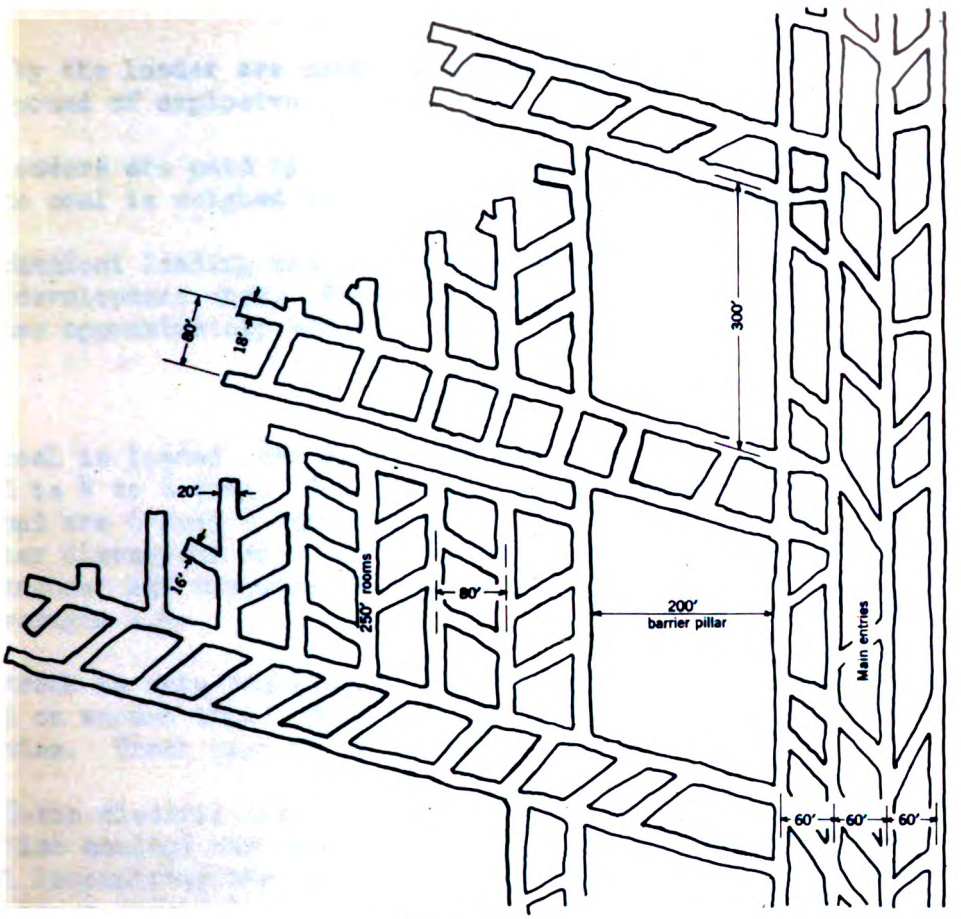
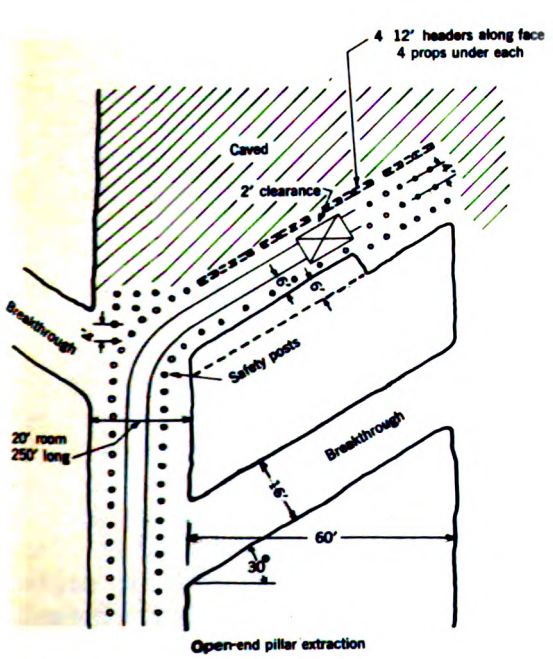
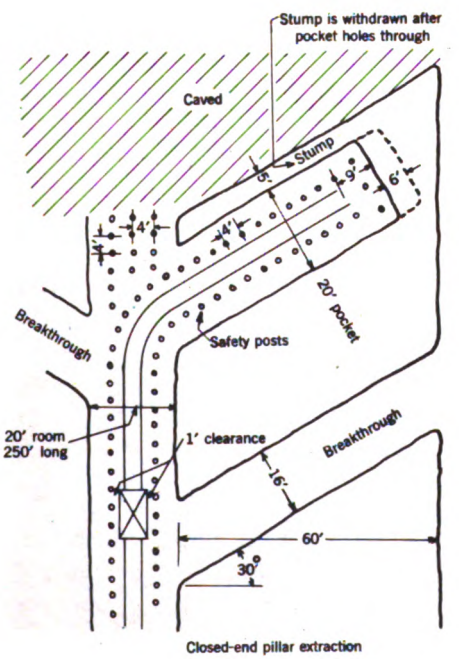


Plan of development



Open-end pillar extraction



Closed-end pillar extraction

Figure 4.—Plan and details of mine no. 1 showing system of development.

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furnished by the loader are used. Approximately 5.6 tons of coal are produced per pound of explosive.

The loaders are paid by the ton, and they average 10.4 tons per man per shift. The coal is weighed in mine cars on platform scales in the head house.

A mechanical loading machine with a crew of eight men is used intermittently in development work. When in operation the machine runs two shifts and produces approximately 400 tons, or 25 tons per man.

Haulage

All coal is loaded into steel mine cars of 109 cubic feet capacity. The usual load is 4 to 6 tons. The cars are of the end-dump type with anti-friction bearings and are 6 feet 6 inches wide, 10 feet 6 inches long, and 16 inches deep. Other dimensions are: Height above top of rail, 26 inches; wheelbase, 3 feet 4 inches; and diameter of wheels, 12 inches. The mine car turn-over per day averages 1.9.

The track in main haulageways and branch entries is constructed of 40-pound rail on wooden ties. Room track is built of 30-pound rails supported on steel ties. Track gage is 48 inches.

Two 6-ton electric locomotives connected in tandem (one unit) are used for main-line haulage and handle 12 to 25 cars per trip. Six 6-ton trolley cable-reel locomotives are used for gathering. Empty cars are taken from partings or storage tracks in various sections of the mine to the working faces, and loaded cars are brought from the faces to these partings by the gathering locomotives. They are then picked up by the main-line locomotive and delivered to the storage track at the dumping station above the tipple.

The loaded cars are uncoupled and run by gravity over platform scales, thence onto a cross-over dump. The coal passes to a hopper, and the empty cars run by gravity to the empty storage track on the hillside. Here the cars are coupled, and the trips are assembled for the return to the partings or storage tracks.

The coal passes from the main hopper under the dump to buckets on an aerial tramway. The buckets have a capacity of 1-3/4 tons; there are 24 buckets on the line, 22 in motion and 2 at the terminals. A bucket is dumped approximately every 25 seconds. The loaded cable line is 1-3/4 inches in diameter, the return line 1-1/4 inches, and the traction cable 1 inch. The tramway is started by a 50-horsepower electric motor, and the excess energy developed by the loaded buckets moving down the slope of the tramline automatically changes the electric motor to a generator, which feeds power back into the line. This method reduces power peaks. The tramway extends from the dumping station on the hill to the tipple at the railroad tracks, a distance of approximately 1,900 feet. The loaded buckets are dumped automatically into a storage hopper at the tipple.

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Ventilation

Ventilation is furnished by two fans, one blowing and the other exhausting. The control of the ventilating current is effected by several openings that have been made to the outcrop.

The blower, which is a disk fan 6 feet in diameter delivers 24,000 cubic feet of air per minute at 240 r.p.m. It is driven by a 15-horsepower motor. The exhaust fan, which is also of the disk type, 5 feet in diameter, delivers 24,000 cubic feet per minute at 320 r.p.m. This fan is driven by a 10-horsepower motor.

Drainage

Water offers no problem in the mine except after excessive rainfall. Cracks caused by breaks in the strata overlying the coal seam where pillars have been drawn admit surface water to the mine workings. This water is gathered in sumps and discharged by four small electric pumps into ditches that drain to the outside. These pumps are of the plunger type and are drive by 5- and 7-1/2-horsepower motors.

Preparation Plant

The tipple is constructed of steel and is equipped with shaking screens. The coal passes from the hopper at the discharge end of the aerial tramway through a crusher either to railroad cars or to the shaking screens for sizir The screens are the round-hole type. The coal is sized according to demand, as follows:

Inches	Grade	Percent
minus 1 1/2	Slack	65
1 1/2 x 3 ...	Stove	6
3 x 5	Egg	14
plus 5	Lump	15

The lump, egg, and stove sizes pass over picking tables and loading boo The slack is discharged directly into railroad cars.

The crushed coal is usually minus 2 1/2 inches and is shipped to byprod coke plants. The prepared sizes are shipped for domestic consumption.

The tipple tracks have a capacity of 44 empty cars above and 55 cars be low the tipple.

Power

All power used in and about the mine is purchased from a public utilit company and is 2,300-volt, 3-phase, 60-cycle alternating current. This curr is converted for use by haulage locomotives, pumps, and mining machines to 250-volt direct current by a 100-kw. rotary converter and one 100-kw. motor.

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generator set. Average total power consumed was 1.99 kw.-hr. per ton of coal.

Supplies

Mine supplies are transported over an inclined track from the supply yard at the foot of the hill to the yard at the mine. A supply car attached to a 3/4-inch steel cable is hoisted or lowered over this track with a single-drum electric hoist.

Labor

All labor in and about the mine is governed by a wage agreement with District 17, United Mine Workers of America. The various classes of labor with percentages of total men employed are shown in table 1. Man-hours and other data are shown in tables 10 and 11, which are composite tables for all mines in the field.

TABLE 1. - Classification of labor

	Percent of total number employed
Underground	
A. Cutting	4.01
B. Loading	54.23
C. Timbering	3.39
D. Track laying	6.78
E. Ventilation	.62
F. Haulage	6.78
G. Supervision	2.62
H. Miscellaneous	8.63
Total	87.06
Surface	
I. Dumping	1.54
J. Hoisting or lowering	.62
K. Preparation	4.62
L. Supervision and mine office	.62
M. Miscellaneous	5.54
Total	12.94
Grand total	100.00

Mine No. 2

The mine which is situated on the hillside approximately 200 feet from the top, has a half-mile outside haulway from the opening to the dumping station. The coal area is irregular and narrow in places and the outcrop follows the contour of the hills. The seam, which is free from partings, averages

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60 inches in thickness. The roof is draw slate 2 to 12 inches thick, and the "rider seam" is above this. The bottom is a hard, sandy shale.

Method of Mining

The room-and-pillar system of mining is used. The haulageway and air course are driven 16 feet wide on 50-foot centers. Rooms have been turned off the haulageways on 50-foot centers and were driven 18 to 20 feet wide by 250 feet long, but at present they are being turned on 70-foot centers and are driven 18 to 20 feet wide by 300 feet long. Development is driven to conform with the shape of the outcrop.

Pillars are extracted upon retreating, with open-end slabbing. (See fig. 5.)

In timbering entries and rooms 0.18 prop is used per ton of coal mined.

Cutting, Drilling, and Shooting

The coal is undercut with a shortwall mining machine equipped with a 7-1/2-foot cutter bar. The undercut is made 2 to 4 inches above the bottom. The cutting, which averages 8 to 12 places per shift, is all done at night. The amount produced per cut ranges from 20 to 28 tons.

A crew of two men (driller and shot firer) drills three holes in the face after a place has been undercut. The holes are placed near the top, one at each rib and one in the center, and are drilled with an electric drill to the depth of the undercut. Shots are prepared with pellet powder and fired by the shot firer. An average of 5.12 tons of coal is produced per pound of explosive.

The mining-machine crews are paid a day wage.

Loading

Loading is done with a mechanical loading machine in all but three headings. The coal from these headings is loaded by hand.

The loading-machine crew consists of a runner, three helpers, and two men on the locomotive. One car at a time is placed under the conveyor of the loading machine by a 4-ton electric locomotive. As soon as all the coal is loaded from a place, the latter is timbered and prepared for the cutting crew. Figure 5 shows a working place with position of loading machine and crew. The coal is loaded into 5-ton steel mine cars of the end-dump type.

Haulage

The mine-car turnover per day is 1.46.

The track in entries and rooms is constructed with 25-pound rails. Wooden ties are used in entries and steel ties in rooms.

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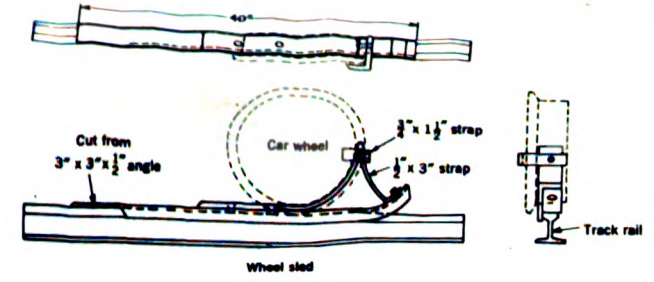

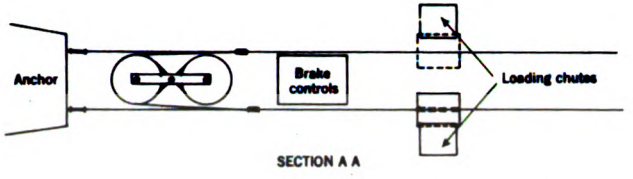

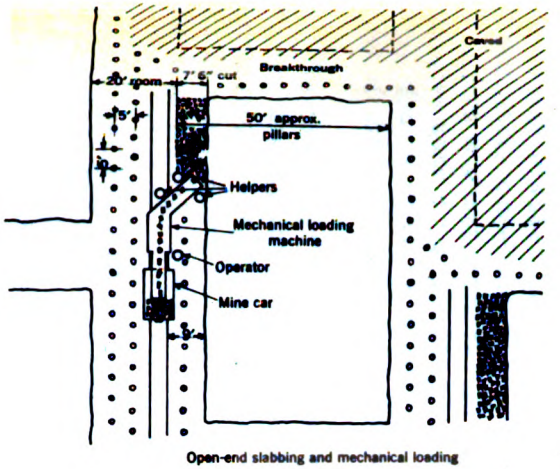

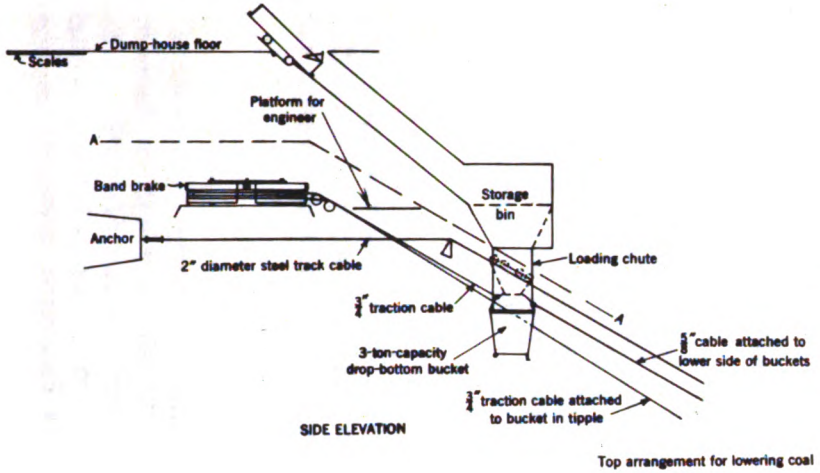

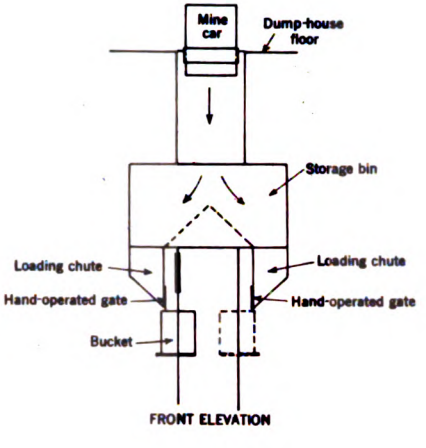

Top arrangement for lowering coal

Figure 5.—Mine No. 2.

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The coal is gathered with a 6-ton trolley and cable-reel locomotive and is hauled to an inside parting or storage track. It is then transported to the dumping station in trips of 8 to 12 cars with a 6-ton trolley locomotive. Approximately one-half mile of the haul on surface is around the hills, part of it down a steep grade. All cars are equipped with brakes, but to prevent excessive wear from sliding of the wheels two wheel sleds are used on each trip. Such a sled is shown in figure 5. A wheel sled is placed on opposite sides of the car, one on a front wheel and one on a rear wheel.

The loaded trip is placed on a storage track at the dumping station; the cars are uncoupled and pass directly to the horn dump, where the coal is dumped into a bin with a capacity of approximately 60 tons. The bottom of the bin is constructed to divert the coal into two pockets for loading into buckets on an aerial tramway. (See fig. 5.)

The aerial tramway is constructed of two steel-wire track cables 2 inches in diameter, and the operation is similar to that of a gravity incline plane. The two track cables are stretched taut and are anchored at each end to heavy draw bolts set in concrete. Two 3-ton buckets, one on each track cable, are attached to a 3/4-inch steel cable on the upper side and a 5/8-inch steel cable on the lower side. The loaded bucket pulls the empty up the tram from the tipple at the railroad to the bin at the dumping station. Movement of these buckets is regulated by a figure-8 control, which consists of two drums on vertical axes with the traction ropes passing around them. (See fig. 5.) The speed of the buckets is controlled by hand brakes on the drums. The incline operator is stationed at the dump house.

The buckets, which are of the drop-bottom type, discharge the coal into a hopper at the tipple, from which it is loaded directly into the railroad cars as mine run or is passed through a crusher and crushed to 2-1/2-inch size. No prepared sizes are made. The tipple is of wooden construction and has only one track. The empty storage for railroad cars above the tipple has a capacity of seven cars, and there is ample space below the tipple for loads.

Ventilation

A 5-foot disk exhaust fan driven by a 10-horsepower electric motor furnishes 21,000 cubic feet of air per minute. The air enters the mine at the main opening and, after circulating around the faces, is discharged by the fan.

Power

Electric current, which is 2,300 volt, 3-phase, 60-cycle, is purchased from a public utility company. It is stepped down at the mine by transformers to 220-volt alternating current and converted to 250-volt direct current with a 100-kw. motor-generator set. Direct current is used for all purposes in the mine - cutting, loading, and haulage. Average total power consumed was 2.72 kw.-hr. per ton of coal.

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Supplies

Supplies are hauled up the hill from the railroad to the mine in a car over a tram road. A 37-horsepower alternating current motor furnishes the power for a 14-inch single drum hoist, which raises and lowers the material car.

Labor

All employees are paid a day wage as set out in the contract with the United Mine Workers. The classification of labor is shown in table 2, and man-hours and other data, which are composite for the field, are shown in tables 10 and 11.

TABLE 2. - Classification of labor

	Percent of total number employed
Underground	
A. Cutting	5.26
B. Loading	31.58
C. Timbering	2.63
D. Track laying	5.26
E. Ventilation	2.63
F. Haulage	15.79
G. Supervision	5.27
H. Miscellaneous	15.79
Total	84.21
Surface	
I. Dumping	2.63
J. Hoisting or lowering	2.63
K. Preperation	5.27
L. Supervision and mine office	2.63
M. Miscellaneous	2.63
Total	15.79
Grand total	100.00

Mine No. 3

The coal seam outcrops approximately 850 feet above the railroad. The outcrop follows the contour of the hills, as at other mines in the field, and the shape of the coal body is very irregular. The seam varies in thickness character. An average section is as follows:

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	Inches
Pyrite and shale	1/16
Coal	5
Bone	1
Coal	10
Bone	2
Coal	26 1/2
Bone	1 1/2
Coal	3

At many places there are thin shale partings in the coal strata 1/16 to 1/2 inch thick.

The roof varies from sandstone to hard, sandy shale. Where sandstone is present there is no draw slate. Where draw slate is present it averages 6 inches in thickness. The "rider seam" is absent.

Mining Methods

Development is governed by the shape of the outcrop and is planned for maximum recovery. The room-and-pillar system of mining is used. Entries are driven 14 to 20 feet wide with haulageway and air course on 70-foot centers. Rooms are turned at right angles to the haulageway on 70-foot centers and are driven 20 to 24 feet wide by 200 feet long. The rooms are driven through to the air course of the next entry.

Pillars are drawn on the retreat, using the pocket or closed-end system. The pillar is cut through, and the width of the stump between pockets is usually the depth of one machine cut, similar to figure 4. As a rule all of these stumps are recovered.

Timbering

Entries are timbered with one row of props on each side of the track spaced approximately on 5-foot centers. Rooms are timbered in the same manner, except that the centers between props average 6 feet. Usually one safety timber is set for each loader. Where pillars are being drawn, five props are set per cut. About 0.20 prop is used per ton of coal mined.

Cutting

Both shortwall and track-cutting machines are used. Shortwall machines are equipped with 7-1/2-foot cutter bars, and they cut in the coal just below the bottom band of bone, which is 2 or 3 inches above the bottom. From 10 to 12 places are cut per shift.

The track machines cut near the top in the 5-inch band of coal. These machines cut 20 to 22 places per shift. Two men (a runner and a helper) are employed on each type of machine.

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All cutting is done after the day shift has completed its run, and the crews are paid on a tonnage basis.

Loading

Two men work at each face. The loaders set safety timbers, drill the face, prepare and fire the shots with pellet powder, and load the coal. When the coal has been undercut three holes are drilled in the face near the top - one at each rib and one in the center. The middle hole is charged and fired, a the coal produced by this shot is loaded; then the two rib holes are charged a fired. When the cut has been made near the top by the track machine the holes are drilled at the bottom - one at each rib and one in the center. The rib holes are charged and fired first and then the center hole. Approximately 4.7 tons of coal are produced per pound of explosive.

Loading, which is done by hand, is paid for by the ton, and loaders average 8.33 tons per man per shift.

The coal is loaded into steel mine cars of the end-dump type and 5 tons capacity. Inside dimensions of the cars are: Length 11-1/2 feet, width 7 feet, and height above rail 30 inches. Wheel diameter is 14 inches, and bearings are of the antifriction type. Mine-car turnover is 1.81 per day.

Haulage

The track in the main entries is laid with 60-pound rails and in room entries and rooms with 25-pound rails. Wooden ties are used in entries and steel ties in rooms.

Gathering is done with 5-ton trolley and cable-reel locomotives that operate from the inside storage tracks or partings to the faces. A 13-ton trolley locomotive hauls to and from the inside partings to the dumping station with trips of 17 or 18 cars. Loaded cars are placed on a storage track, uncoupled and weighed singly on platform scales. From the scales the loaded cars pass to a crossover dump, and the coal is discharged into a bin. The empty cars run by gravity to a kickback and are returned to the empty-storage tracks parallel to the loaded track.

The coal is discharged from the bin into a 10-ton monitor. These monitors operate over an incline 1,750 feet long, the loaded monitor pulling the empty up the plane. The speed of operation of the monitors is regulated by a figure-8 control from the dumping station. The figure-8 control consists of two 7-foot-diameter drums, the axis of each of which is vertical and parallel and spaced about 10 feet between centers. The faces of these drums are 3 feet wide, and the center portion of the face is grooved for three turns of 1-1/4 inch steel cable. The brakes are two steel bands 12 inches wide on each drum lined with wooden blocks and a composition brake lining. The steel cable to which the monitors are attached passes around the drums in the form of a figure 8. The arrangement of this control is similar to that shown in figure 5.

The monitors are of the end-dump type and upon reaching the bottom of

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the incline automatically discharge the coal into a bin with a capacity of approximately 10 tons. The coal is then elevated to the tipple on an apron-type conveyor 30 inches wide. It is driven by a 75-horsepower motor using alternating current.

Ventilation

Air is taken in through the main haulageways, and after it has passed through the working faces it is exhausted by the fan. This is a disk fan 7 feet in diameter and driven by a 7-1/2-horsepower electric motor.

Preparation Plant

The tipple is of wooden construction, equipped for loading on four tracks. Coal is delivered by apron conveyor onto shaking screens for sizing and afterward passes over picking tables and loading booms to railroad cars. The following sizes and approximate percentages are made:

Inches	Grade	Percent
Minus 2	Screenings	57
2 x 3	Stove	8
3 x 5	Egg	15
Plus 5	Lump	20

Power

Electric power, which is purchased from a public utility company, is 2,300-volt, 3-phase, 60-cycle, alternating-current. It is stepped down to 230 volts alternating current by transformers. Direct current for use on mining machines and haulage locomotives is produced by a 100-kw. rotary converter. All electric motors in and around the tipple use 230-volt alternating current. Average total power consumed was 2.39 kw.-hr. per ton of coal.

Supplies

A track for transporting materials and supplies to the mine is built on the hillside adjacent to the monitor line. Power for raising and lowering the supply car is furnished by a 35-horsepower, single-drum electric hoist.

Labor

Wage rates and working conditions are governed by contract with the United Mine Workers. Classification of labor is shown in table 3. Tables 10 and 11 are composites for the field showing man-hours and other data.

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TABLE 3. - Classification of labor

	Percent of total number employed
Underground	
A. Cutting	5.31
B. Loading	63.66
C. Timbering	1.59
D. Track laying	5.30
E. Ventilation	1.06
F. Haulage	8.49
G. Supervision	2.92
H. Miscellaneous	2.12
Total	90.45
Surface	
I. Dumping	0.53
J. Hoisting or Lowering	.53
K. Preparation	4.25
L. Supervision and mine office	1.06
M. Miscellaneous	3.18
Total	9.55
Grand total	100.00

Mine No. 4

The outcrop of the coal seam is approximately 200 feet below the top o the hills. The thickness of the seam ranges from 46 to 72 inches and avera about 60 inches. There are two bone partings 1 to 4 inches thick, one 18 i ches from the top and the other 18 inches from the bottom of the seam. The roof is draw slate 2 to 20 inches thick, and above this is a hard shale. T bottom is a hard, sandy shale.

Mining Methods

The contour of the outcrop is irregular, and the development is planne to conform with the shape of the coal body. The mining system is room-and- pillar. Entries, which consist of haulageway and air course, are driven 1 to 20 feet wide on 70-foot centers. Rooms are turned on 70-foot centers a right angles to the haulageway and are usually 20 feet wide by 200 feet lo

Pillars are drawn retreating, and in most places the closed-end or pocket system of pillar extraction is used. The open-end method is used where the roof will permit. Small stumps are sometimes left if the entire pillar cannot be withdrawn because of poor roof.

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Timbering

All entries are timbered with props, one row on each side of the track, and three props usually are used for each cut. A row of props is also set on each side of the track in rooms using four props for each cut. Headers or caps are used where the draw slate is thick. These extend from prop to prop parallel to the face. Approximately 0.20 prop is used per ton of coal mined.

Cutting

Undercutting is done 2 to 4 inches above the bottom with shortwall mining machines equipped with 6-1/2- and 7-1/2-foot cutter bars. Each machine is operated by a runner and helper, who work at night. Approximately 10 places are cut per shift with each machine. Payment for cutting is on a tonnage basis.

Loading

After the places are undercut the faces are drilled with an electric drill and shot on the night shift by crews of two men. Three holes are usually drilled near the top of each working place, there being one at each rib and one in the center. One pound of explosive, which is 2-inch pellet powder, produces 5.6 tons of coal.

The loaders, on entering their working place, set safety timbers and proceed to load the broken coal into mine cars. Two men, as a rule, work in a place; however, in some instances there is only one man. Loaders are paid by the ton and average 10.2 tons per man per shift.

Haulage

Entry track is constructed with 60-pound rails laid on wooden ties. Track in rooms is laid with 30-pound rails on steel ties. The track gage is 48 inches.

Steel mine cars with a capacity of approximately 5 tons are of the end-dump type equipped with brakes. They have the following dimensions - length 11-1/2 feet, width 7 feet; and the top of the bed is 30 inches above top of rail. Wheels are 14 inches in diameter and bearings are of the antifriction type. Mine-car turnover is 1.80 per day.

Gathering from inside working faces to partings or storage tracks is done with 6-ton trolley and cable-reel locomotives. An 8-ton trolley and cable-reel locomotive is used for main-line haulage to and from the dumping station outside the mine, and trips consist of 10 to 20 cars.

The loaded trip is placed on the storage track at the dumping station; the cars are uncoupled and weighed on a platform scale, then pass to a cross-over dump, where the coal is discharged into a bin. The empty car runs by gravity to the empty storage track on the hillside.

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The coal is discharged from the bin through a hand-operated gate into a monitor having a capacity of 12 tons. Monitors operate over a gravity incline plane approximately 2,000 feet long. The plane is constructed with three rails, except for a short space in the center of the line, where four rails permit passage of two monitors. The speed of travel is controlled by brakes on the drum, which are operated by the engineer in the dump house. Two steel cables are fastened to the 14-foot diameter drum and wound in opposite directions. The other ends of the cables are attached to the monitors. The arrangement of this type of incline control is similar to that at mine No. 6.

The monitors are of the drop-bottom type, and the coal is automatically dumped at the foot of the incline into a hopper of 12 tons capacity. The coal is elevated from this hopper to the tipple by a belt conveyor 40 inches wide. This conveyor is driven by a 10-horsepower electric motor.

Ventilation

A 6-foot exhaust disk fan driven by a 5-horsepower electric motor furnishes air for ventilation of the mine.

Preparation Plant

The wooden tipple is equipped with a crusher, shaking screens, three loading booms, and four loading tracks. The shaking screens, which have plate with round perforations, are driven by a 25-horsepower electric motor. When the coal is not crushed the following sizes and approximate percentages of eac size are usually produced:

Inches	Grade	Percent
Minus 2	Screenings	63
2 by 3	Stove	8
3 by 6	Egg	9
Plus 6	Lump	20

All sizes of coal pass over picking tables and loading booms, and the slack is loaded directly into railroad cars. Coal is crushed to minus 2-1/2 inches when it is sold for byproduct purposes.

Power

Electric power is purchased, and 2,300-volt, 3-phase, 60-cycle, alternat ing current is furnished. It is converted to 250-volt direct current by a 1(kw. rotary converter for use in the mine. Tipple motors are run by alternat current, which is stepped down at the tipple to 230 volts. Average total pov consumed was 2.39 kw.-hr. per ton of coal.

Supplies

Mine supplies are transported from the supply yard near the tipple to t yard near the pit mouth over the monitor track when coal is not being lowere

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Track switches are provided at the top and bottom of the monitor track so that the material car can be readily handled. The material hoist, which is driven by a 15-horsepower motor, has a 30-inch diameter drum with a 22-inch face.

Labor

All labor is governed by a wage agreement with District 17, United Mine Workers of America. Classification of labor is shown in table 4. Tables 10 and 11 are composites for the field and show man-hours and other data.

TABLE 4. - Classification of Labor

	Percent of total number employed
Underground	
A. Cutting	3.59
B. Loading	57.40
C. Timbering	1.79
D. Track laying	5.38
E. Ventilation	.90
F. Haulage	9.97
G. Supervision	4.03
H. Miscellaneous	2.69
Total	84.75
Surface	
I. Dumping	0.90
J. Hoisting or lowering	.90
K. Preparation	7.17
L. Supervision and mine office	.90
M. Miscellaneous	5.38
Total	15.25
Grand total	100.00

Mine No. 5

This mine is opened near the top of the mountain, approximately 670 feet above the railroad. The seam ranges in thickness from 49 to 58 inches, including partings. A section of the seam is as follows:

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	Inches	
Slate	--	
Sandstone	60	
Draw slate	4	
Rash	1	
Coal	19	
Bone	5	
Coal	17	Coal section
Mud band	3/8	
Bone	3	
Coal	12	
Total section	57-3/8	

The rash at the top of the coal seam is discarded at the face, and the coal above the mud band is loaded out. The mud band is then easily removed with a shovel, and the lower section of the seam is loaded. The two sections of "bone" resemble a splint coal and are loaded with the coal. This bone is low in ash.

The draw slate above the coal seam averages 6 inches in thickness and usually falls to the sandstone roof. The rider seam is absent in this mine. The bottom varies from sandstone to shale.

There are local dips but no excessive grades. The general dip of the seam is to the northwest.

Method of Mining

The room-and-pillar system of mining is used. The plan of development is governed by the shape of the outcrop, which follows the contours of the hills. Main entries, which consist of entry and air course, are driven near the center of the coal body, and branch entries are turned off the mains at 250-foot intervals. These headings are usually driven 14 feet wide on 60-foot centers. Break-throughs between entry and air course are also on 60-foot centers. Rooms are turned off the entries on 60-foot centers and are driven 20 to 30 feet wide by 250 feet long. They break through to the air course of the next entry. Crosscuts between rooms are driven at an angle of 45° from the face on 60-foot centers.

The track in the rooms is placed along the inside rib. Usually two props are set 8 feet from the face and parallel to it. Rows of props are s on approximately 4-foot centers and staggered. (See fig. 6.)

The roof in the entries is good, and little or no timbering is require

Pillars are drawn open-ended, starting at the connection between the r at the face and the air course.

In the "open-end" method the cutting machine starts across the inside corner of the pillar at approximately 45° from the track. Successive cuts

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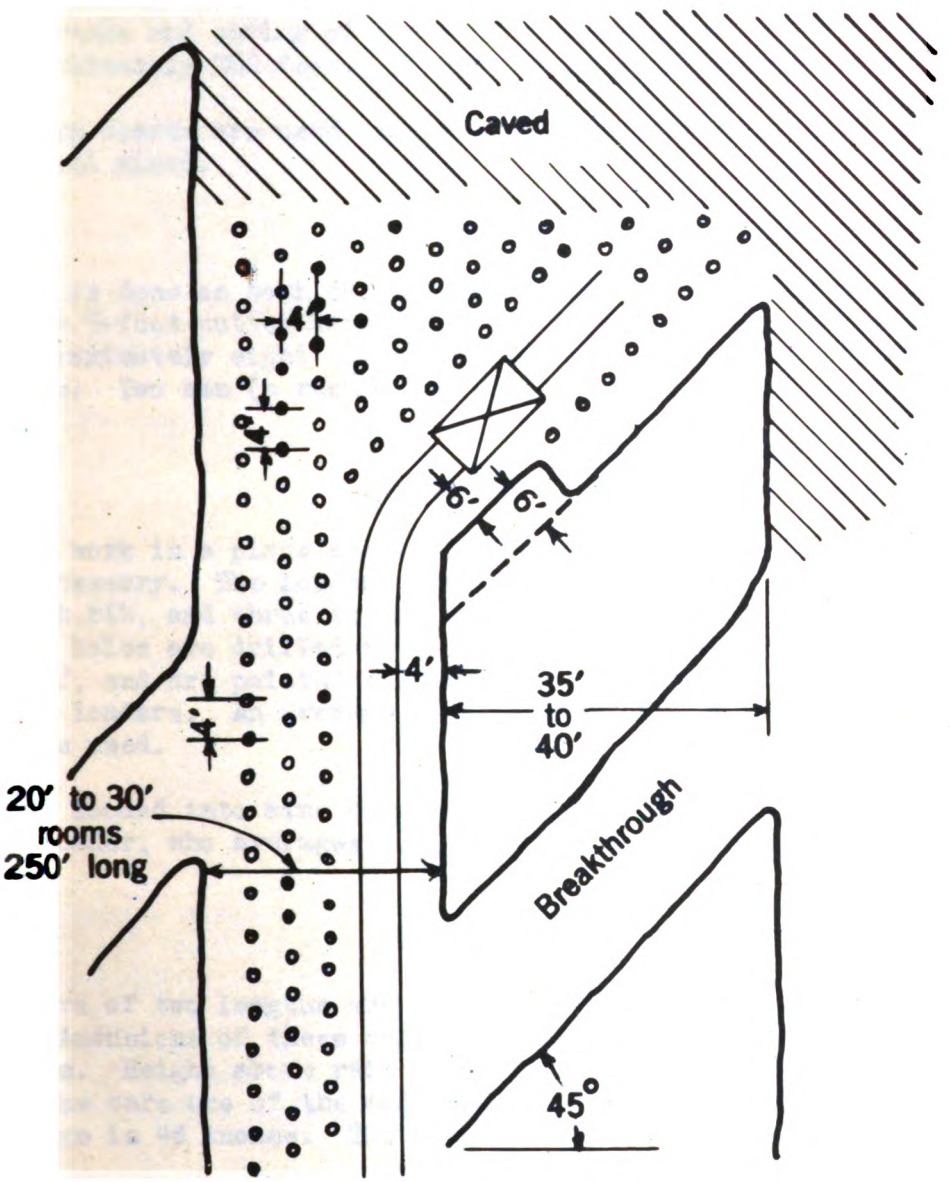

Figure 6.— Details of pillar extraction and timbering at mine no. 5.

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made across this long face, and the room track is curved and moved parallel to this pillar face. Pillar robbing does not begin until all the rooms in a section have been worked out. The robbing then begins "retreating." Figure 6 is a sketch showing this method of pillar extracting with the system of timbering used. Breaks and caving of the roof usually occur after robbing has retreated approximately 200 feet. No attempt is made to recover props.

Split cap boards are used on props, and an average of 0.13 prop is used per ton of coal mined.

Cutting

Cutting is done on both day and night shifts with shortwall machines equipped with 7-foot cutter bars. The cut is made 2 to 4 inches above the bottom, and approximately eight places are cut per shift. Each place averages about 25 tons. Two men (a runner and helper) operate each machine at a daily wage.

Loading

Two men work in a place and load the coal by hand. They set safety timbers when necessary. The loaders drill two holes in the face of the headings, one near each rib, and three in the rooms, one near each rib and one in the center. All holes are drilled to the depth of the cut, start 8 inches down from the roof, and are pointed slightly upward. The shots are prepared and fired by the loaders. An average of 6.25 tons of coal is produced per pound of explosives used.

Coal is loaded into mine cars having a capacity of approximately 2-1/2 tons. The loader, who averages 6.91 tons per shift, is paid on a tonnage basis.

Haulage

Mine cars of two lengths are in use; both are of wooden construction. The inside dimensions of these cars are: Length 9 feet and 11 feet, width 5 feet 6 inches. Height above rail is 28 inches, and wheels are 14 inches in diameter. The cars are of the end-dump type equipped with plain bearings. The track gage is 48 inches. The mine-car turnover averages 2.53 per day.

The track is constructed of 40-pound rails in entries and 25-pound rails in rooms. Both wooden and steel ties are used in rooms.

The coal is gathered with two locomotives - one a 5-ton trolley and cable reel and the other a 5-1/2-ton storage battery. These locomotives receive empty cars at the inside partings or storage tracks and deliver them to the room switches, where they receive loaded cars for return to the parting. Ten cars usually constitute a gathering trip. A 5-ton trolley locomotive used for main haulage pulls trips of 25 cars from the partings to the loaded storage tracks at the head house. A locomotive crew consists of a motorman and brakeman. The distance from mine mouth to dump is approximately 1,600 feet over a surface tram.

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The loaded cars are uncoupled and weighed on platform scales. After being weighed they pass by gravity to a cradle or horn dump, and the coal is discharged into a hopper. The empty cars run from the dump by gravity to the empty storage track, adjacent and parallel to the loaded storage track.

The coal is discharged from the hopper into a 6-ton monitor or car, which runs over a gravity plane 1,600 feet long. The track, which is 44-inch gage, is constructed of three rails, except for a short distance near the center where four are used to allow the cars to pass. There are two monitors connected to a drum 8 feet in diameter by 12 feet long with steel cables, which are wound in opposite directions on the drum. The weight of the loaded car pulls the empty car up the incline. The speed of the monitors is regulated by two band brakes, one on each end of the drum. The engineer operates the monitor line from the dump house, which is directly over the upper end of the monitor tracks.

The monitor, which is of the bottom-dump type, discharges the coal automatically into a hopper at the tipple.

Ventilation

A 5-foot disk fan driven by a 15-horsepower electric motor ventilates the mine. The air enters the main haulageway and after being distributed throughout the mine workings is exhausted to the outside by the fan.

Drainage

The mine is self-draining, so that pumping is unnecessary.

Preparation Plant

The coal passes by gravity from the hopper to an apron conveyor and is elevated to the shaking screens in the tipple. Screens are of the step-plate type and various sizes of prepared coal from 3/4-inch screenings to plus 8-inch lump are made; 1-1/4-inch screenings average 60 percent. The tipple machinery is driven by a 20-horsepower direct-current motor. The tipple, which is of wooden construction, is equipped with three tracks and has two loading booms and picking tables. There is storage for 28 empty cars above the tipple and for 38 loaded cars below.

Power

All electric current is purchased from a public utility company. This 2,300-volt, 60-cycle, 3-phase, alternating current is converted to direct current at the mine by a 100-kw. rotary converter. Direct current is used for all purposes in and about the mine and tipple at 250 volts. Average total power consumed was 1.91 kw.-hr. per ton of coal.

Supplies

Mine supplies are taken from the tipple yard to the mine in a car that is pulled over the monitor track by a single-drum electric hoist at the mine.

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The wire rope handling this car is independent of the monitor line. The material track is connected with the monitor line near the dumping station at the mine, and another switch is turned off the monitor line near the tipple. When the material car is in operation the monitor on the material track side is kept at the top of the line so that the monitor rope will not be on the track.

Labor

Virtually all of the mine workers are native whites. The mine is operated with union labor under contract agreement with the United Mine Workers of America, District 17.

Data referring to labor are shown in tables 10 and 11. Classification of labor according to number of men employed is shown in table 5.

TABLE 5. - Classification of labor

	Percent of total number employed
Underground	
A. Cutting	4.79
B. Loading	65.86
C. Timbering	.60
D. Track laying	5.99
E. Ventilation	.60
F. Haulage	5.99
G. Supervision	2.40
H. Miscellaneous	1.79
Total	88.02
Surface	
I. Dumping	2.40
J. Hoisting or lowering	1.20
K. Preparation	3.59
L. Supervision and mine office	.60
M. Miscellaneous	4.19
Total	11.98
Grand total	100.00

Mine No. 6

The outcrop of the coal seam on this property is near the top of the hills, and at some places the body of coal is narrow. The seam is comparatively level, although there are local dips. The thickness of the seam varies. An average

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section is as follows:

	Inches
Draw slate	5
Coal	29
Bone	1-1/2
Coal	11-1/2
Slate (middleman)	10-1/2
Coal	11

The stratum above the draw slate is hard shale, which makes a good roof. The rider seam of coal is absent. The bottom beneath the coal is also a hard shale.

Only the section of the coal seam above the "middleman" is mined. The draw slate generally falls after the coal is removed.

Mining Methods

The room-and-pillar system of mining is used. Main entries are driven through the center of the body of coal. They consist of a haulageway and air course, which are 14 feet wide and on 50-foot centers. Rooms are turned off the haulage entry on 50-foot centers and are usually driven 20 feet wide and 250 feet long. Break-throughs are made between rooms on about 80-foot centers. The mine is in the development stage, and the main entries are being advanced as rapidly as possible. No roof has been taken down nor bottom lifted (top or bottom brushing) to obtain greater clearance above cars. Rooms are turned as the entries advance, and no pillars are being drawn.

Timbering

The track is laid in the center of the rooms, and a row of props is set on each side of the track on approximately 7-foot centers along the length of the room. Safety timbers are set by the loader at the face when needed. Approximately 0.13 prop is used per ton of coal mined.

Cutting

The coal is undercut in rooms and entries with shortwall mining machines equipped with 7-foot cutter bars. The undercut is made from 2 to 4 inches above the bottom, and 16 to 20 tons are obtained from each cut. Two men operate each machine, a runner and helper. All cutting is done at night and is paid for at a tonnage rate according to the wage agreement.

Loading

The loaders, usually two to a working place, drill the coal face, which has been undercut, and prepare and fire the shots. Three holes are drilled near the top - one near each rib and one in the center of the face. Approximately 3.28 tons of coal are produced per pound of explosive. The broken

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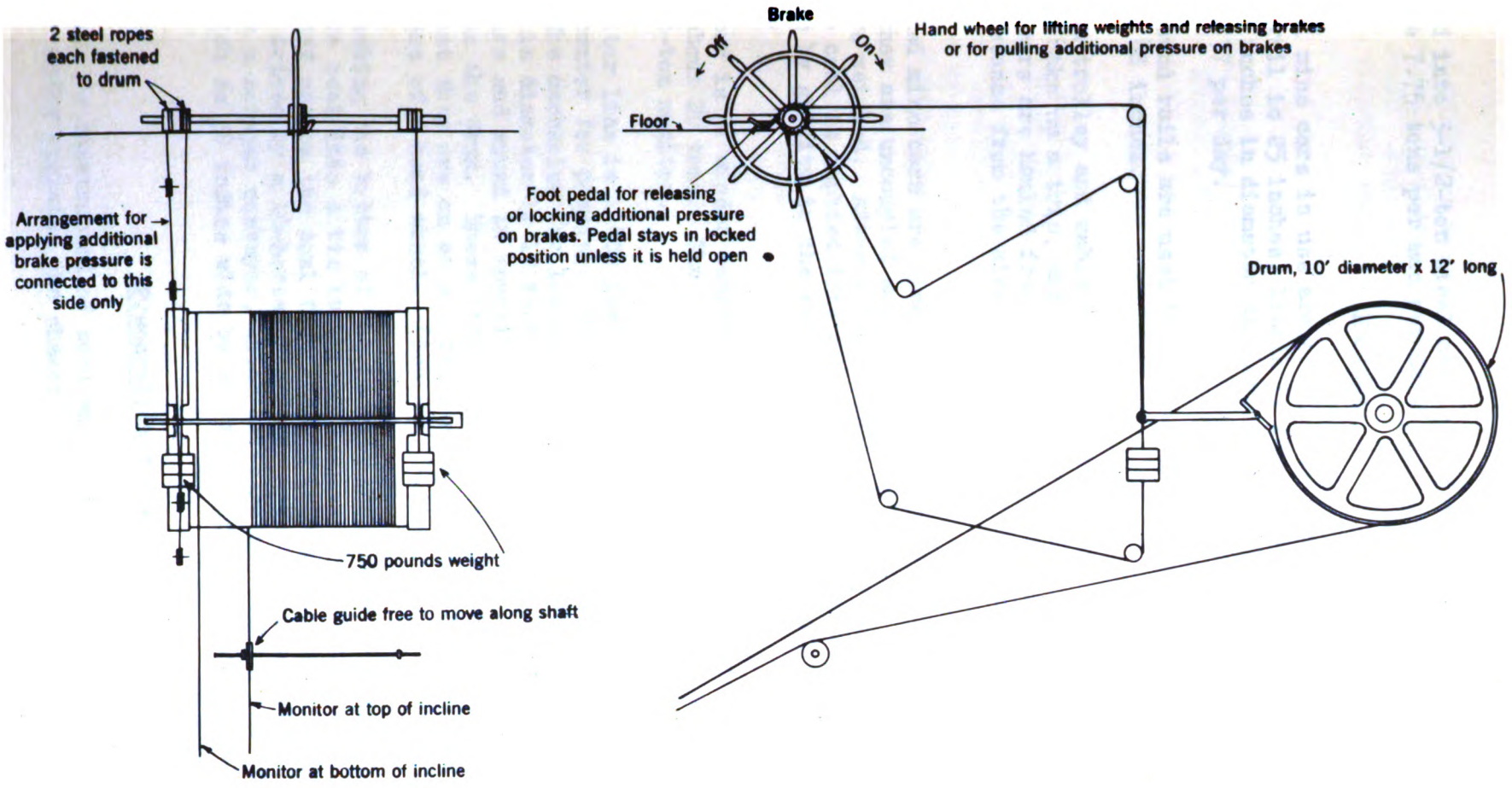
2 steel ropes each fastened to drum
Brake
Off
On
Hand wheel for lifting weights and releasing brakes or for pulling additional pressure on brakes
Floor
Foot pedal for releasing or locking additional pressure on brakes. Pedal stays in locked position unless it is held open
Arrangement for applying additional brake pressure is connected to this side only
Drum, 10' diameter x 12' long
750 pounds weight
Cable guide free to move along shaft
Monitor at top of incline
Monitor at bottom of incline

Figure 7.—Arrangement of brakes on monitor control at mine no. 6.

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coal is loaded into 3-1/2-ton steel cars. Loaders, who are paid on a tonnage basis, average 7.75 tons per man per day.

Haulage

The steel mine cars in use are of the end-dump type equipped with brakes. Height above rail is 25 inches, length 11 feet, and width 6-1/2 feet. The wheels are 14 inches in diameter and have antifriction bearings. The mine-car turnover is 1.77 per day.

Thirty-pound rails are used in entries and 25-pound rails in rooms. The track gage is 48 inches.

Two 4-ton trolley and cable-reel locomotives are used for haulage. Six or seven cars make up a trip, and as there are no inside storage tracks or partings the cars are hauled from the face to the dumping station outside the mine. The distance from the mine opening to the dumping station is approximately 600 feet.

The loaded mine cars are placed on a storage track at the dumping station. Here they are uncoupled and dropped by gravity to a platform scale, where they are weighed. After being weighed they pass to a cradle or horn dump, and the coal is emptied into a hopper or bin. The empty cars return from the dump by gravity to the empty storage, which is parallel to the loaded track.

The hopper is of wooden construction lined with steel plates and has a capacity of about 20 tons. The coal is discharged through a hand-operated gate into a 6-ton monitor.

The monitor line is 1,400 feet long and constructed of three rails, with four at the center for passing. The loaded monitor, when lowered, pulls the empty car. The mechanism for lowering the coal consists of a cylindrical drum 10 feet in diameter by 12 feet in length, with two steel cables attached to the monitors and wound in opposite directions on the drum. There are two band brakes on the drum. These brakes are connected with ropes, pulleys, and weights so that they are on at all times except when the engineer lifts the weight by means of a hand wheel. (See fig. 7.)

Upon reaching the bottom of the incline the loaded monitor automatically discharges the coal into a bin having a capacity of approximately 25 tons. An apron feeder passes the coal from the bin onto a short apron conveyor, both of which are driven by a 10-horsepower motor. The apron conveyor discharges the coal onto a scraper conveyor, which delivers the coal to the tipple. This conveyor, which is 30 inches wide by 200 feet long, is driven by a 60-horsepower motor.

Preparation Plant

The tipple is constructed of wood and equipped with shaker screens. A 10-horsepower motor operates the shaker. The screens are of the step-plate

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type, and slack, egg, stove, and lump are prepared according to demand. The egg, stove and lump sizes are run over picking tables and loading booms into railroad cars. The slack passes directly into the cars. There are three loading tracks under the tipple, and there is storage capacity for 30 empty cars and 48 loads.

Supplies

Supplies for the mine are transported in a special car over the monitor line and hoisted by a single-drum electric hoist. The supply track is connected to the monitor line at both the top and bottom of the incline.

Power

Electric power used in and about the mine is purchased from a public utility company. It is 3-phase, 60-cycle, alternating current, furnished at 2,300 volts and stepped down by transformers to 220 volts for use in and about the mine and tipple, except for haulage and cutting machines. The direct current used in these operations is 250-volt and is converted by a 100-kw. motor generator set at the mine. Average total power consumed was 2.34 kw.-hr. per ton of coal.

Labor

Classification of labor used in and about the mine is shown in table 6. Wage rates and conditions are governed by contract with the United Mine Workers of America, District 17. Man-hours and other data are shown in tables 10 and 11, which are composite tables for all mines in the field.

TABLE 6. - Classification of labor

	Percent of total number employed
Underground	
A. Cutting	8.57
B. Loading	57.14
C. Timbering	2.86
D. Track laying	5.71
E. Ventilation	1.43
F. Haulage	8.57
G. Supervision	4.29
H. Miscellaneous	1.43
Total	90.00
Surface	
I. Dumping	2.85
J. Hoisting or lowering	1.43
K. Preparation	2.86
L. Supervision and mine office	1.43
M. Miscellaneous	1.43
Total	10.00
Grand total	100.00

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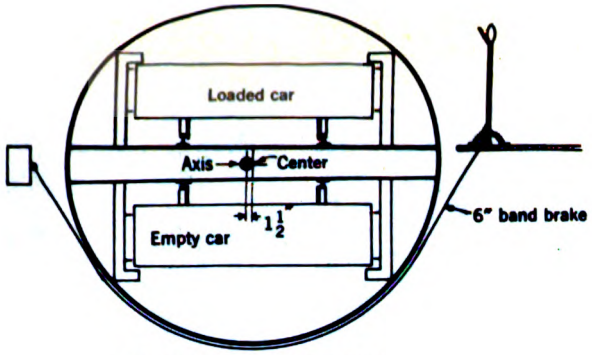
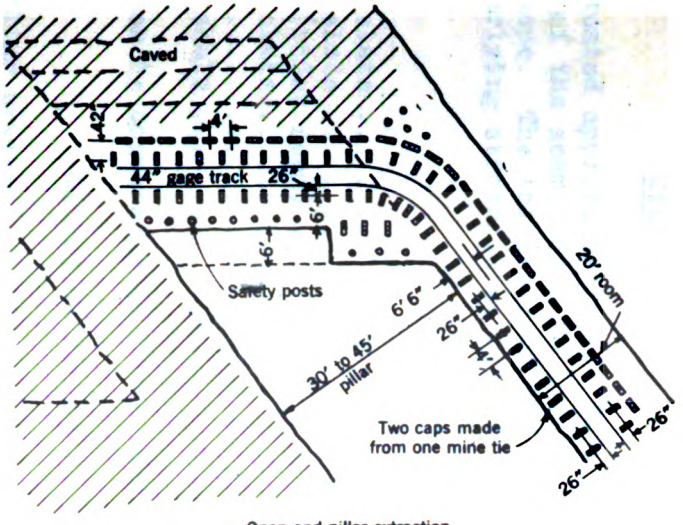
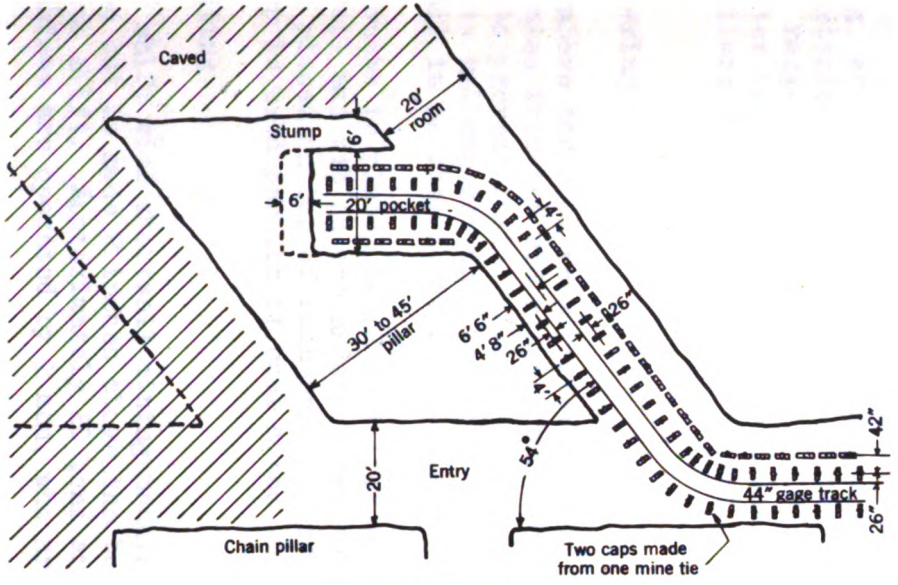


Gravity rotary dump arrangement



Open-end pillar extraction



Closed-end pillar extraction

Figure 8.—Mine no. 7.

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Mine No. 7

The mine is situated approximately 110 feet below the top of a range of hills. The outcrop of the seam, which follows the contour of the hills, is very irregular in shape. The thickness of the seam varies, but an average section with the overlying strata is as follows:

	Inches
Hard slate	--
Draw slate	5
Coal (rider seam)	10
Draw slate	20
Coal	50-1/2
Hard shale	--

Although the seam is comparatively level, there are local dips.

Method of Mining

The room-and-pillar system is used, and development is governed by the shape of the coal body. As a rule entries are driven to divide the areas so that maximum recovery can be obtained. Entries, which consist of a haulageway and air course, are driven 20 feet wide on 50-foot centers. Rooms, which are usually 20 feet wide and 225 feet long, are turned off the haulageway at an angle of 54° from the entry and are extended to the air course of the next entry. Distance between room centers ranges from 50 to 60 feet. Room entries are driven toward the outcrop, and after all rooms are turned and the last room has been driven its distance, pillars are pulled on the retreat. (See fig. 8.)

Timbering

The thickness of the draw slate above the coal seam varies greatly but averages 20 inches. It usually separates from the rider seam, and a considerable amount of timbering is required to prevent falls. All entries are timbered with sets consisting of two posts and cap set on 4-foot centers along the entry. Clearance above top of rail in entries is about 38 inches.

The center line of the track in rooms is placed 6-1/2 feet from the rib. One row of props is set between the rail and rib on one side and two rows are set on the other side. A half tie is placed on top of each prop to serve as a cap. (See fig. 8.) About 0.32 prop is used per ton of coal mined.

Cutting

All cutting is done on the night shift with shortwall mining machines equipped with 6-foot cutter bars. The cut is made 2 inches above the bottom, and 10 to 14 places are cut per machine shift. Approximately 20 tons are produced from each cut. The cutting machines are operated by 2 men, who are paid on a tonnage basis.

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Loading

Generally two men work in a place and load the coal by hand. The loaders drill the coal face and place 3 holes in a 20-foot place. One hole is drilled near each rib, usually 12 inches from the rib and 12 inches below the roof, and one hole is placed in the center of the face, also 12 inches down from the roof. All holes are drilled approximately 6 feet deep and pointed slightly upward so that the bottom of the holes are approximately 4 inches from the roof. The loaders do not shoot the face, as this is done by shot firers, who prepare the shots with pellet powder and fire them after the cut has been made. Approximately 3.15 tons of coal are produced per pound of explosive. The loaders, who are paid on a tonnage basis, average 8.46 tons per man per shift.

The coal is loaded into closed-end steel mine cars and is weighed in the cars on platform scales at the dump house.

Haulage

The mine cars have either a 3- or 4-ton capacity. The 4-ton car is 7 feet wide by 12 feet long, and the top of the bed is 28 inches above the top of rail. The 3-ton car is 6 feet wide by 11 feet long and is 21 inches above top of rail. The wheels of both sizes of cars are 14 inches in diameter and equipped with antifriction bearings. The mine-car turnover is 2.54 per day.

Track gage is 44 inches. Main haulage tracks are constructed of 50-pou rails, and track in room headings and rooms is of 30-pound rails. All rails are laid on wooden ties.

After the cars are loaded at the face, one 7-ton storage battery and tw 5-ton trolley and cable-reel locomotives gather the loaded cars from rooms and transfer them to storage tracks or partings. Trips of loaded cars are hauled from partings to the loaded track at the dumping station with a 7-ton trolley locomotive. The cars are uncoupled at the loaded storage track and are weighed and passed to a gravity rotary dump (fig. 8), where the coal is discharged into a bin. After the car is dumped and returned to the upright position it is pushed off the dump by a loaded car and runs by gravity to th empty storage track on the hillside.

The coal is discharged from the bin onto an apron feeder, which feeds into a rope-and-disk conveyor. This conveyor carries the coal down the hill to the tipple. The conveyor is constructed of a steel-lined wooden trough in which the rope and disks operate. The disks are 12 inches in diameter, and the steel cable is 1 inch in diameter. The conveyor is on a 19-1/2° slope 1,300 feet long and has a capacity of 85 tons per hour. It is operated by 50-horsepower electric motor.

Ventilation

Ventilation is provided by two exhaust fans - one a 5-foot disk fan driven by a 10-horsepower electric motor and the other a 4-foot disk fan op ated by a 7-1/2 horsepower electric motor. The smaller fan produces 12,000 bic feet of air per minute, and the other produces 30,000 cubic feet per mi

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Drainage

The average depth of cover is 60 feet and the maximum 110 feet. There are frequent breaks in the overlying strata that permit surface water to enter the mine. Ditches carry this water to the outside, so that the mine is self-draining.

Preparation Plant

The coal is discharged from the rope-and-disk conveyor onto the shaker screens. The shaker is equipped with round-hole screens for sizing the coal into various grades. It is driven by a 25-horsepower electric motor. The larger sizes pass over picking tables and loading booms into railroad cars. The tipple, which is of wooden construction, is equipped with 3 loading tracks and has storage capacity for 20 empty and 25 loaded railroad cars.

Power

Electric power is purchased from a public utility company and is delivered to the mine as 2,300-volt, 3-phase, 60-cycle alternating current. It is stepped down to 220 volts for service. A 150-kw. rotary converter furnishes 250-volt direct current for haulage and cutting machines. Average total power consumed was 2.50 kw.-hr. per ton of coal.

Supplies

A material track is constructed up the hillside and extends from the railroad yard to the supply yard at the mine. A 25-horsepower electric hoist equipped with drum having a 14-inch diameter and a 26-inch face is used to raise and lower the material car.

Labor

Contract stipulations as to wages and conditions of labor are governed by agreement between the operator and District 17 of the United Mine Workers of America. Classification of labor is shown in table 7, and man-hour and other data, which are a composite for the field, are shown in tables 10 and 11.

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TABLE 7. - Classification of labor

	Percent of total number employed
Underground	
A. Cutting	5.72
B. Loading	61.90
C. Timbering	.95
D. Track laying	4.76
E. Ventilation	.95
F. Haulage	7.62
G. Supervision	4.76
H. Miscellaneous	2.86
Total	89.52
Surface	
I. Dumping	1.91
J. Hoisting or lowering	.95
K. Preparation	4.76
L. Supervision and mine office	.95
M. Miscellaneous	1.91
Total	10.48
Grand total	100.00

Mine No. 8

The outcrop of the coal seam is on the hillside and is irregular in shape. Two typical sections of the coal seam showing its variable thickness are as follows:

	Inches
Blue-shale roof	--
Coal	12
Bone	2
Coal	42
Shale	18
Coal	6
Coal bottom	--
Blue-shale roof	--
Coal	10
Bone	4
Coal	32
Shale	8
Coal	4
Shale	3
Coal	21

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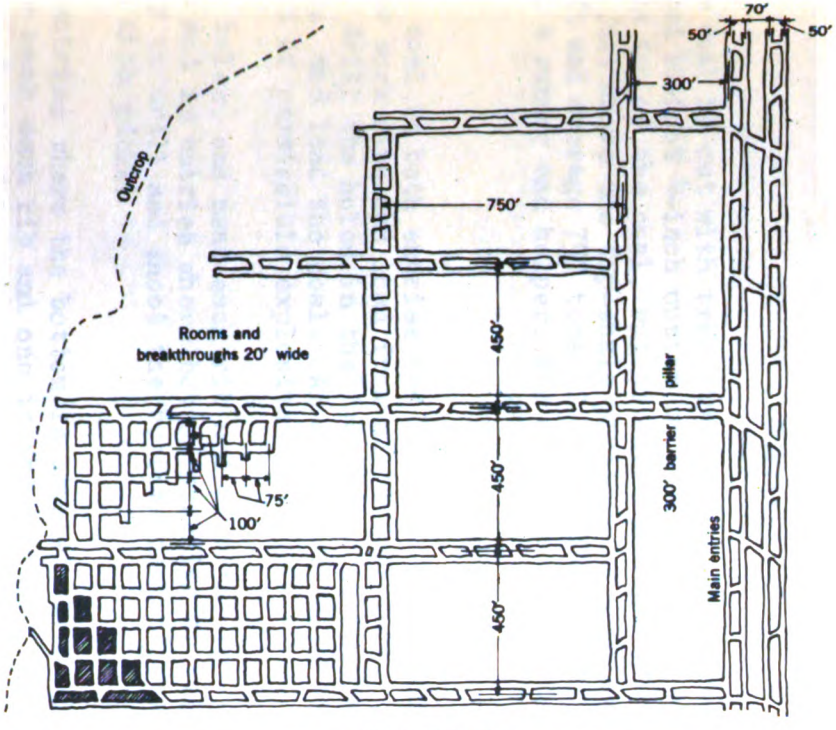
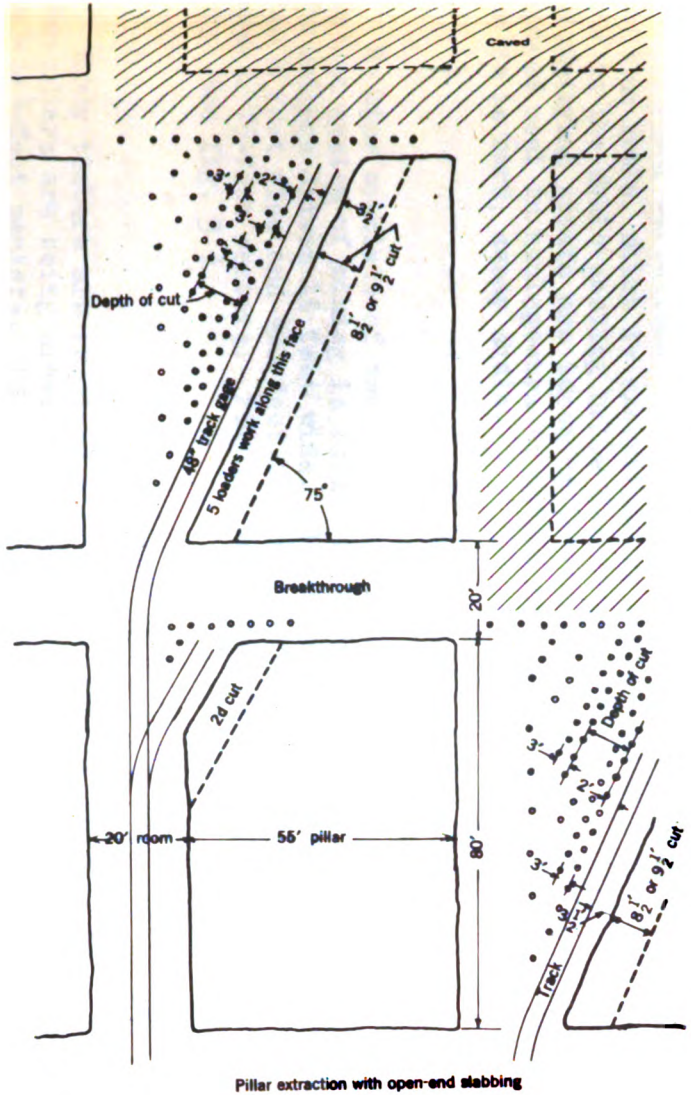


Plan of development



Pillar extraction with open-end slabbing

Figure 9.—Plan and details of mine no. 8.

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The prevailing dip of the seam is slightly to the northwest, but there are small local variations at a number of places in the mine. The roof is a hard, blue shale, which is exceptionally good. The bottom, except in entries, is the shale parting below the second section of coal. This shale and underlying strata are taken up (bottom brushing) to include the lower strata of coal in haulageways to obtain more clearance above the track. Under this is hard, sandy shale.

Mining Methods

The mine consists of two separate units, both using a common tipple. The block system of mining is used. (Fig. 9.) The main entries consist of four headings driven 18 feet wide. Branch entries are turned off the mains. Rooms 20 feet wide and 400 feet long are turned at right angles off the haulageway on 75-foot centers. Pillars are drawn retreating with open-end slabbing. (See fig. 9.)

Timbering

Safety timbers are required only at the face of entries and rooms. Where pillars are being drawn, rows of timbers are set parallel to the track on 3- to 4-foot centers. (See fig. 9.) The number of props used per ton of coal mined is 0.07, but this will increase as the ratio of pillar work to development increases.

Cutting

The coal is cut with track-type mining machines equipped with 9-foot 4-inch and 10-foot 4-inch cutter bars. The cut is usually made 24 inches below the top of the coal, but in entries where bottom brushing is done it is made just above the top-shale parting. A machine will cut about 30 places per shift and average 750 tons of coal. The cutting machines are operated by two men, a runner and helper, who are paid on a tonnage basis.

Loading

All coal in both entries and rooms is hand-loaded into cars. As a rule in pillar work five men load from an 80-foot face. The loaders set safety timbers, drill the holes in the face after it has been cut, prepare and fire the shots, and load the coal. An average of 5.16 tons of coal is produced per pound of permissible explosive.

Two holes, one near each rib and near the top, are drilled in the face of rooms and in entries where bottom brushing is not required. It is unnecessary to drill and shoot the bottom bench of coal because it can be loosened with picks.

In entries where the bottom is brushed three holes are drilled near the top - one near each rib and one in the center. After the coal above the shale parting is shot and loaded into cars the coal directly under the shale is shot

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and loaded. The coal below the parting is loaded without further shooting. If the shale parting is divided by a thin layer of coal it is usually not necessary to shoot it. The coal is loaded into steel mine cars and paid for on a tonnage basis. The loaders average 10.75 tons per man per shift.

Haulage

Track in main haulage entries is constructed of 60-pound rails laid on wooden ties. Main-line switches use a No. 4 frog. In rooms and room entrie 30-pound rails, steel ties, and switches with No. 2-1/2 frogs are used. The track gage is 48 inches.

The steel mine cars are of the solid-end type with an average capacity of 5 tons. The cars are 7 feet wide by 12 feet long. Wheels are 14 inches in diameter and bearings are of the antifriction type. The average mine-car turnover is 2.29 per day.

Gathering is done with 6-ton trolley and cable-reel locomotives that deliver empty cars from the inside partings or storage tracks to the working faces and return the loaded cars. A 10-ton trolley locomotive is used for main-line haulage from the partings to the outside dumping stations. The trips usually consist of 17 cars.

The loaded trips are placed on a storage track at the dumping station. The cars are not uncoupled, and the trip is passed as a unit over platform scales by a chain feeder, each car being weighed automatically and then dumped by a rotary dump. This dump is electrically operated and rotates 360° in dumping. The cars are equipped with swivel couplings, which permit them to be dumped by the rotary into a bin without uncoupling. After all of the cars in the trip have been dumped the trip passes by gravity to the empty storage track.

The coal drops by gravity from the bin at the rotary dump onto a reciprocating feeder and then passes to the shaking screens.

Ventilation

As some gas is generated in the mine, closed lights are used. Ventilation is provided at one unit by an 8-foot propeller-type fan direct-connected to a 40-horsepower electric motor. This fan is on the intake (blowing) and furnishes 46,500 cubic feet of air per minute against a 1-inch water gage. It has a capacity of 120,000 cubic feet of air per minute. At the other unit a 5-foot propeller-type fan, direct-connected to a 15-horsepower electric motor, furnishes 45,000 cubic feet of air per minute against a 1-inch water gage. It is also on the intake (blowing) and is running at full capacity. The mine is rock-dusted.

Drainage

The water is collected in various sumps and is pumped into ditches by three 15-horsepower centrifugal pumps and one 5-horsepower plunger pump.

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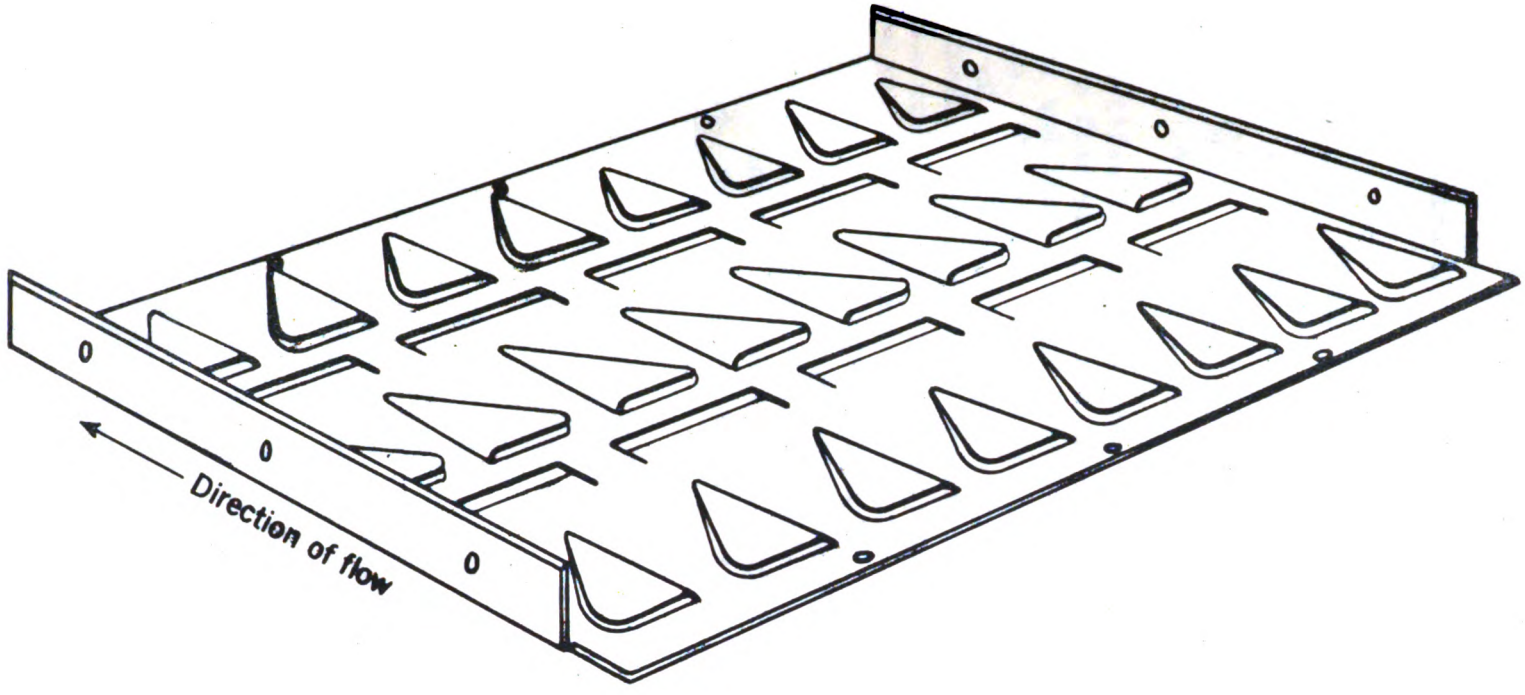

Figure 10.— Slate picker at mine no. 8.

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Tipple

The tipple is of four-track design and constructed of steel. The shaker is equipped with various sizes of screens for preparing the coal according to demand. Screen plates are of both the step-plate type and round-perforation type. The following tabulation shows the grades, sizes, and relative amounts of coal produced.

Inches	Grade	Percent
Plus 6	Lump	10
3 by 6	Egg	10
3 by 1-1/4	Stove	15
Minus 1-1/4	Slack	65

Some of the impurities in the coal are flat pieces of shale with pyrite, which are removed by a flat picking plate arranged under the screens. The 3- by 1-1/4-inch coal and the 1-1/4- by 1-inch coal pass over 80 square feet of this type of plate. The picker consists of steel plates with right and left staggered rows of raised C-shaped leaves and alternate depressed rectangular leaves. These slotted openings are set against the forward and backward movement of the coal. As the screens reciprocate, the coal and flat pieces of shale are moved forward and the coal rides over the raised leaves and slots, while the pieces of shale pass through the slots. Should the shale fragments be thrown backward, they would pass through the slots arranged against the backward movement of the material. The height of the leaves can be adjusted according to the thickness of the flat pieces of shale. (See fig. 10.) The lump, egg, and stove sizes pass over picking tables and loading booms into railroad cars.

There is storage capacity for 80 empty railroad cars above and 100 loads below the tipple.

Power

Electric power, which is purchased from a public utility company, is 6,600-volt, 3-phase, 60-cycle, alternating current. The current is stepped down by transformer to 440 and 110 volts for use in and around the tipple. A 300-kw. synchronous converter produces direct current at 250 volts for use on haulage and mining machines. Average total power consumed was 1.92 kw-hr. per ton of coal.

Supplies

An electric crane is used to unload mine supplies from railroad cars. These are taken in mine cars to the mine with a trolley locomotive over a grade built from the railroad yard along the hillside.

Labor

All mine workers are native whites and are paid according to the rates specified in the contract with the United Mine Workers of America. Classifi-

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cation of labor is shown in table 8, and the composite sheets for the field, showing man hours and other data, are given as tables 10 and 11.

TABLE 8.- Classification of labor

	Percent of total number employed
Underground	
A. Cutting	3.16
B. Loading	56.14
C. Timbering	1.76
D. Track laying	9.12
E. Ventilation	1.93
F. Haulage	5.26
G. Supervision	2.11
H. Miscellaneous	5.96
Total	85.44
Surface	
I. Dumping	9.35
J. Hoisting or lowering	---
K. Preparation	4.39
L. Supervision and mine office	1.40
M. Miscellaneous	8.42
Total	14.56
Grand total	100.00

Mine No. 9

This mine is near the top of the hills, and the coal area is irregular in shape. The coal seam averages 60 inches in thickness and usually contains a 3-inch streak of high-ash coal about 18 inches from the top. The roof consists of 4 inches of draw slate underlying a hard shale.

The room-and-pillar system of mining is used. Rooms 20 feet wide by 3(feet long are driven on 40- or 60-foot centers. Only development work is be ing done, and to date no pillars have been drawn.

The coal is cut near the bottom with a shortwall mining machine equipp with a 7-foot cutter bar. The machine men cut, drill, and shoot on the nig shift. An electric drill is used, and three holes are drilled for each cut Holes are charged with pellet powder, and an average of 4.58 tons of coal i produced per pound of explosive.

Two timbers are usually set for each cut, and timbering averages about 0.07 prop per ton of coal mined.

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A locomotive places the mine cars at the face for the loaders, who load by hand, two men to a place. The solid-end, steel mine cars have a capacity of 5 tons. The mine-car turnover is 4.3 per day.

The coal is lowered in the mine car from the mine to the tipple over a gravity incline plane, a loaded car pulling the empty back up to the mine. The track on the incline plane consists of three rails, with four at the center for passing. A drum equipped with brakes controls the speed of lowering and raising the single mine cars.

The mine cars are dumped by a gravity cradle dump (rotary). The axis of the dump is about 1-1/2 inches from the center of gravity, and the weight of the loaded car causes it to overturn. After being dumped the empty car is righted by means of a steel cable attached to an electric hoist. The dump is equipped with a counterweight to balance the weight of the empty car.

The coal passes from the chute underneath the dump to a reciprocating feeder and then to a 30-inch pan conveyor and is conveyed to the tipple. The tipple is of frame construction, and only mine-run coal is loaded, but preparation is being made for three loading tracks and tipple machinery. When shaking screens are installed various sizes will be prepared.

Electric power is purchased from a public utility company at 2,300-volt, 3-phase, 60-cycle, alternating current. All motors connected to machine in and around the tipple operate on 440-volt alternating current. Transformers step the 2,300 volts down to 440. Direct current for use in the mine is produced by a 100-kw. motor-generator set at 250 volts. Average total power consumed was 2.80 kw.-hr. per ton of coal.

All labor in and about the mine is paid a day wage in accordance with the contract with the United Mine Workers.

Classification of labor is shown in table 9, and man-hours and other data, which are a composite for the field, are given in tables 10 and 11.

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TABLE 9.- Classification of labor

	Percent of total number employed
Underground	
A. Cutting	6.67
B. Loading	43.33
C. Timbering	3.33
D. Track laying	3.33
E. Ventilation	3.33
F. Haulage	6.67
G. Supervision	3.33
H. Miscellaneous	3.34
Total	73.33
Surface	
I. Dumping	3.33
J. Hoisting or lowering	3.33
K. Preparation	13.34
L. Supervision and mine office	3.33
M. Miscellaneous	3.34
Total	26.67
Grand total	100.00

SUMMARY

At most of the mines the empty mine cars are loaded on the night shift, and the number of loaders employed is governed by the mine-car supply. The loaded coal is run over the tipple on the following day shift. The tipples run 7 to 14 hours per day, but the starting time of the various employees is so arranged that none of them work more than a 7-hour shift.

Power contracts stipulate a demand charge, which is based on the highest peak in any 15-minute period. This demand charge is a fixed one and is not credited to the energy used. "Demand limiters" have been installed at some of the plants to minimize the demand charge. The demand limiter is se to cut out certain circuits should the demand reach a predetermined peak.

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The schedule of wage rates as set out in the contract between the Operators Association and the United Mine Workers of America, District 17, is as follows:10/

Day Rates

The following hourly and day wage rates shall be paid in all mines:

Classification of occupation	Hourly rate	Day rate
Inside		
Machinemen	$0.78	$5.46
Motormen, rock drillers	.751	5.26
Drivers, brakemen, spraggers, snappers, coal drillers, trackmen, wiremen, bonders, timbermen, bottom cagers	.729	5.10
Dumpers, trackmen, helpers, wiremen helpers, timbermen helpers, and other inside labor not classified	.694	4.86
Greasers, trappers, flaggers, switch throwers	.50	3.50
Loading-machine operators (coal)	.928	6.50
Loading-machine operators' helpers (coal)	.78	5.46
Loading-machine operators (rock)	.888	6.22
(If the present rates plus the 70 cents per day increase are higher than those shown above, the higher rates shall apply.)		
Cutting-machine operators and helpers (This rate applies only to cutters and helpers cutting in connection with mechanical coal-loading machines.)	.928	6.50
Shot firer	.728	5.10
Coal drillers	.728	5.10
Outside		
Bit sharpener, car dropper, trimmer, car repairman, dumpers	.62	4.34
Sand driers, car cleaners, other able-bodied labor	.586	4.10
Slate pickers	.50	3.50

Skilled labor not classified to be paid in accordance with the custom at the mine.

10/ Appalachian and Williamson District Agreements to March 31, 1937, pp. 41-43.

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Schedule - Basic Rates

Machine loading: Base rate, 51.8 cents per ton, to be broken down and applied against seams of various thicknesses of coal as follows:

Coal under 48 inches in thickness, 54.2 cents per ton.
Coal 48 inches in thickness and over, 50.2 cents per ton.

In measuring thicknesses for these rates the total height of the seam minus the total thickness of defined partings of impurities rejected in loading shall be considered the height of the seam.

Cutting, shortwall machine	0.076
Cutting, track machine	.0532

Yardage

The handling of the normal impurity in the seam, plus four (4) inches of top slate, is included in the loading rate; additional slate will be paid for at the rate of $0.0719 (seven and nineteen hundredths cents) per inch per lineal yard. That is to say that a place having five (5) inches of top slate will be paid $0.0719 (seven and nineteen hundredths cents) per lineal yard.

Where slate is shot in either top or bottom to make additional height for haulways it shall be done by day men, or the loader shall be paid at the regular hourly basic rate, or piecework rate may be established by mutual agreement.

Water Yardage. When a miner performs labor to handle water he will be compensated at rates applied by local management.

Table 10 has been computed from data collected at all of the mines and shows the average, maximum, and minimum tons per man per day and man-hours per net ton. Table 11 has been computed from dollar costs and shows the percentage of total labor cost and percentage of total mine cost. These table are a composite of the mines in operation at present.

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The classes of underground labor A to H inclusive, shown in tables 10 and 11, are:

A. Cutting:
- Machine boss.
- Machinemen.

B. Loading:
- Shooters and drillers.
- Loaders.
- Loading machinemen.
- Loading machinemen helpers.

C. Timbering:
- Timbermen.
- Timbermen helpers.

D. Track laying:
- Trackmen.
- Trackmen helpers.

E. Ventilation:
- Fire boss.
- Ventilation men.

F. Haulage:
- Motormen.
- Brakemen.

G. Supervision:
- Superintendents and assistants.
- Safety engineer.
- Mine foremen and assistants.
- Section boss.

H. Miscellaneous:
- Wiremen and helpers.
- Trappers.
- Slatemen.
- Laborers.
- Pumpers.
- Pipemen and helpers.

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The classes of surface labor, I to M, shown in tables 10 and 11, are:

I. Dumping and tallying:
- Dumpers.
- Weigh boss.

J. Hoisting or lowering:
- Engineers, man and material hoisting.
- Engineers, hoist.

K. Preparation:
- Tipple boss.
- Tipplemen and car trimmers.

L. Supervision; including mine office:
- Outside foreman.
- Master mechanic.
- Clerks.

M. Miscellaneous:
- Blacksmith.
- Carpenters.
- Mine-car repairer.
- Car droppers.
- Car couplers.
- Aerial trammen.
- Supplymen.
- Lampmen.
- Outside laborers.
- Coal inspector.
- Electricians.
- Trackmen.

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TABLE 10.- Labor used in mining

	Tons per man per day			Man-hours per net ton		
	Average	Maximum	Minimum	Average	Maximum	Minimum
Underground						
A. Cutting	129.1	191.1	51.7	0.054	0.135	0.037
B. Loading	9.7	20.8	6.9	.723	1.013	.336
C. Timbering	278.4	760.0	150.0	.025	.047	.009
D. Track laying	79.6	150.0	66.1	.088	.106	.047
E. Ventilation	424.3	800.0	150.0	.016	.047	.008
F. Haulage	81.0	114.7	41.7	.087	.168	.061
G. Supervision	195.8	286.7	103.3	.037	.068	.025
H. Miscellaneous	107.3	310.0	41.7	.065	.168	.023
Total[1/]	6.4	7.8	4.9	1.095	1.422	.896
Surface						
I. Dumping and tallying	468.9	1720.0	150.0	0.015	0.047	0.004
J. Hoisting or lowering[2/]	547.0	1000.0	150.0	.013	.047	.007
K. Preparation	118.8	155.0	37.5	.059	.186	.045
L. Supervision	495.0	800.0	150.0	.016	.047	.011
M. Miscellaneous	99.0	310.0	71.7	.070	.098	.023
Total	42.0	55.6	18.7	.168	.374	.126
Total underground[1/] and surface	5.6	6.6	4.4	1.263	1.580	1.064

1/ Exclusive of deadwork and yardage.
2/ Exclusive of one mine that has tipple on grade of pit mouth.

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TABLE 11.- Percentage of labor and mine costs, computed from cost in dollars

	Percentage of total labor cost			Percentage of total mine cost		
	Average	Maximum	Minimum	Average	Maximum	Mini
Underground						
A. Cutting	6.66	9.90	5.35	---	---	-
B. Loading	53.47	57.76	32.28	---	---	-
C. Timbering	1.97	3.36	.76	---	---	-
D. Track laying	6.86	8.35	3.36	---	---	-
E. Ventilation	1.25	3.20	.59	---	---	-
F. Haulage	6.98	15.75	5.01	---	---	-
G. Supervision	3.81	7.60	2.45	---	---	-
H. Miscellaneous	4.89	14.78	1.47	---	---	-
Total[1]	85.89	88.73	75.36	72.76	75.74	6
Surface						
I. Dumping and tallying	1.06	2.85	0.30	---	---	
J. Hoisting or lowering[2]	.53	2.86	.49	---	---	
K. Preparation	3.96	11.62	2.82	---	---	
L. Supervision	1.03	4.61	.48	---	---	
M. Miscellaneous	4.55	6.38	1.24	---	---	
Total	11.13	24.64	8.89	9.43	21.10	
Total underground[1] and surface	97.02	100.00	93.23	82.19	85.86	
Deadwork and yardage	2.98	6.77	0	2.53	5.97	
Total labor	100.00	---	---	84.72	88.14	
Materials				11.68	13.85	
Power				3.60	7.22	
Total	---	---	---	100.00	---	

1/ Exclusive of deadwork and yardage.
2/ Exclusive of one mine that has tipple on grade of pit mouth.

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Coal Recovery

The development of most of the mines discussed has been planned for maximum extraction. Because the coal does not have well-defined cleavage planes, development is laid out without regard to cleavage. So far work in most of the mines has been confined to development. Where pillars are being extracted the percentage of recovery appears to be high, probably 85 to 90 percent.

PROBABLE COAL RESERVES, BUCHANAN COUNTY, VA.

Bulletin XVIII, Virginia Geological Survey[4], contains an estimate of the minable coal in seams 14 inches or more thick at 12,032,700,000 tons[11].

An estimate of 600,000,000 tons of available coal from minable seams 3 feet and more thick tributary to the entire Buchanan branch has been furnished by the Norfolk & Western Railroad.

Figures 1, 2, and 3 show the coal areas of seams 4 feet and more thick. Using these maps as a basis, and from sections of seams and other data described in Bulletin XVIII, the authors have prepared the following estimate, using a recovery of 83-1/3 percent.

Original minable coal 4 Feet and over in thickness
Buchanan County, Va.

Seam	Acres	Average thickness, inches	Net tons
Clintwood	11,500	58	83,300,000
Eagle	7,500	55	51,500,000
Splash Dam	11,200	57	79,700,000
Lower Banner	9,600	57	68,400,000
Raven	5,500	54	37,100,000
Total	45,300		320,000,000

There are areas of other seams, but because of their physical characteristics, quality, and location they are not considered as having commercial value at present.

[11] See reference 4, pp. 247 and 248.

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